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ISTC Division VIII Reports on

BORON STEELS

EDITED BY

Harry B. Knowlton, Chairman of ISTC Division VIII—Boron Steels and Supervisor, Materials Engineering, International Harvestor Co.

FOR half a century the development of high-strength low-weight automotive parts has been associated with the development of heat-treatable alloy steels. Nickel, chromium, vanadium, and molybdenum have all been used in the production of automotive alloy steels. These same elements have also been used in much larger percentages for corrosion-resisting and heat-resisting steels, the need for which is steadily increasing. For an all-out military production, the demands for such steels for both mechanical properties and for heat resistance will be enormous. It has even been predicted that under such conditions, little or no alloying elements will be available for nonmilitary production.

Fortunately we are learning how to produce the degree of strength, toughness, and other properties required for individual automotive parts, without the use of as much alloy as was commonly employed 10 years ago. It has sometimes been claimed that certain alloying elements produced almost mysterious beneficial properties in steel. One of the leading metallurgists in the steel industry has said that if all the metallurgists who attempted to produce high hardness without loss of toughness were laid end to end, it would be a good thing! During the last war it was found that automotive steels could be satisfactorily specified for many purposes on the basis of "hardenability." The National Emergency Steels were created on the basis of duplicating the hardenability of the higher alloy steels previously employed. In at least 75% of the applications, these steels worked out satisfactorily. There were some exceptions, but it is believed that a much higher percentage of these steels could have been used with some study.

As a great deal of the discussion on boron steels involves the application of hardenability data it may be well to pause for a brief discussion of the correlation of hardenability data with other useful properties of steel, and the performance of steel parts, such as bolts, steering parts, axles and shafts, springs, and gears.

In the first place, all of these parts are heat-treated so as to produce the hardness, strength, and toughness required for service performance. As a general rule, specifications for finished parts call for a certain type of steel and a certain degree of surface hardness. Sometimes tests for tensile, bending, or torsional strength, or cross-sectional hardness, are also required. The object of all these specifications is to guarantee satisfactory performance.

Parts may fail in service in a number of ways. Abrasive wear is usually associated with lack of surface hardness. Breakage, however, may be due to one or more of the following causes:

1. Lack of strength in the highest stressed area, which may be at the surface, at some point on the cross-section, such as the root of the keyway or spline, or all over the cross-section as in the case of bolts.
2. Lack of sufficient toughness to withstand the degree of bending, twisting, stretching, or other plastic deformation required by service.
3. Presence of residual tensile stresses in highly stressed areas. Such stresses are frequently set up by heat-treatment.

The strength at any point on the cross-section is directly related to the hardness at that point. (See SAE Handbook for conversion of hardness to strength.) In general, toughness is somewhat inversely proportional to strength and hardness. The best relation between strength and toughness, however, is accomplished when the part is thoroughly hardened before tempering. The problem of residual stresses produced by heat-treating is too complicated for thorough discussion in this article. Suffice it to say that in general the less drastic the quench required to produce the desired hardness, the less danger there will usually be of high internal stresses.

In all of these cases it will be noted that the properties of the steel are dependent upon the hardness of the surface and at the cross-section, and the manner in which the steel hardens—in other words, the speed of quenching necessary to produce such hardness. These are all functions of the hardenability of the steel. Hardenability may be defined as the "ease of hardening." Note the difference between hardness and hardenability. It might also be stated that hardenability is inversely proportional to the speed of quenching required to produce a given hardness. The *maximum* hardness which can be obtained depends upon the carbon content of the steel irrespective of alloy. The speed of quenching, on the other hand, which is required to produce this hardness depends upon the hardenability of the steel. For example, a 0.40% carbon steel without alloy might require water or even brine quenching to produce the given hardness, while a higher hardenability steel, like SAE 8640, will attain the same

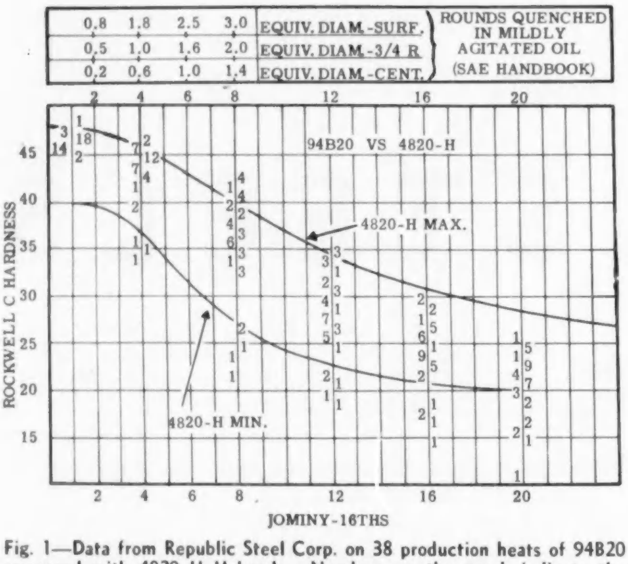

Fig. 1—Data from Republic Steel Corp. on 38 production heats of 94B20 compared with 4820 H H-bands. Numbers on the graph indicate the number of heats showing Jominy readings at the points indicated. Composition was 0.17-0.22% C, 0.20-0.35% Si, 0.30-0.60% Ni, 0.75-1.00% Mn, 0.30-0.50% Cr, and 0.08-0.15% Mo. Boron was added

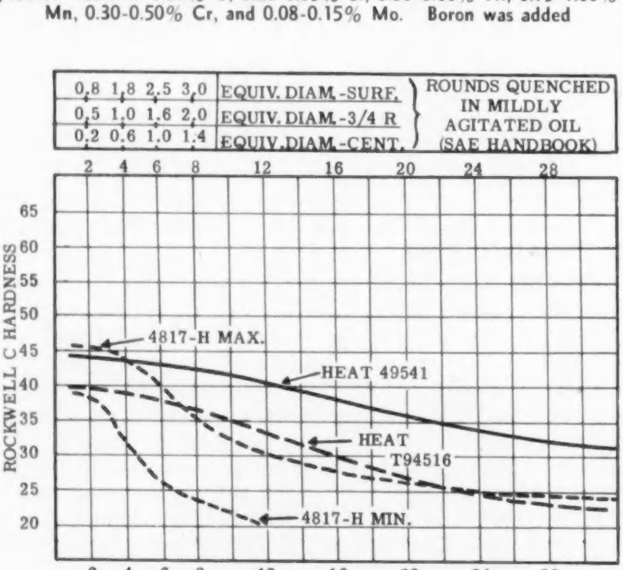

Fig. 2—Data from Republic Steel Corp. on high and low of 20 heats of 43B17 steel compared with 4817 H H-bands. Both minimum and maximum heats had fine grain size and were normalized at 1700 F and quenched from that temperature. Composition of the high-hardenability heat was 0.16% C, 0.73% Mn, 0.32% Si, 1.66% Ni, 0.53% Cr, 0.23% Mo, 0.017% P, and 0.032% S, with boron. Composition of the low-hardenability heat was 0.15% C, 0.59% Mn, 0.32% Si, 1.72% Ni, 0.41% Cr, 0.24% Mo, 0.018% P, and 0.022% S, with boron

hardness with oil quenching. Similarly the higher carbon steel will produce a deeper penetration of hardness. Consequently in selecting an alternate for an alloy steel in current production, it is usually sufficient to duplicate the hardenability of the original steel. Some metallurgists believe that it may not even be necessary to do this, providing the hardenability of the new steel is sufficient to guarantee the hardness and strength in the most highly stressed area of a given part. There is considerable difference of opinion concerning the most desirable penetration of hardness in different parts.

In general if the hardenability of a new type of steel duplicates that of the production steel, it may be expected that the quenching reactions and consequently tendencies toward distortion or internal stresses will be similar.

The hardenability of alloy steels is most commonly measured by the use of the Jominy test. This consists essentially of heating a 1-in. diameter bar, about 3 in. long above the critical point, and quenching one face only in a stream of water. This produces a very high speed of cooling on the quenched face, but successively slower speeds of cooling up the side of the bar. Thus each sixteenth from the quenched end of the bar represents a different speed of cooling in degrees per second. Each of these points may also be correlated with the speed of cooling of the surface of oil-quenched or water-quenched bars of different sizes, or of different points on the cross-section of different size bars after oil or water quenching. This correlation between the Jominy distance from the quenched end to the position on the surface or cross section of oil or water quenched rounds, is shown on the hardenability graphs accompanying the IH report.

Boron Steels

The addition of small quantities of boron-containing compounds to steel is one means of producing the desired hardenability with the minimum amount of other alloying elements, such as nickel, chromium, molybdenum, and vanadium. There are a number of boron ferro alloys on the market which are sold under the trade names of Ferroboron, Borosil, Grainal 1, Grainal 79, Silcaz, and Silvaz. The amount added to the steel is very small, being only about ½-1 lb per ton for Ferroboron, and up to 6 lb per ton for the more complicated alloys. The principal elements contained in these compounds (boron, silicon, aluminum, titanium, zirconium, and calcium) are all found in this country and in fairly plentiful supply. Only difficulty anticipated is possible shortage of electric furnace capacity for making the boron alloy. This, however, can be increased.

The actual amount of boron retained in the steel is extremely small, varying from 0.0007-0.001% for low carbon steels and up to 0.0025% for medium carbon steels. The effect on the hardenability of the steel is equivalent to the addition of many times that percent of other hardening elements, such as nickel, chromium, and molybdenum. The effect of the boron, however, is not directly proportional to the amount of boron present. In this respect, boron differs from other hardening elements, such as manganese, silicon, nickel, chromium, and molybdenum. Addition of larger amounts of boron in the steel is not beneficial and may even cause the steel to be brittle at high temperatures (or "hot short").

So far as the steel user is concerned, it should be remembered that the addition of boron is a means to an end, which is to improve the hardenability of the steel. As the degree of improvement is not proportional to the amount of boron in the steel the best criterion is a test for hardenability produced, not a chemical analysis for the amount of boron.

The foregoing were among the fundamental points brought out in the early meetings of Division VIII.

The American Iron and Steel Institute, with the concurrence of the SAE ISTC, has already published compositions for the tentative standard boron steel

series TS 80BXX and TS 81BXX and for TS 94B17, TS 94B20, and TS 86B45. The TS 80BXX series containing half the nickel, chromium, and molybdenum of SAE 86XX steels is designed to have hardenability equivalent to the SAE 86XX series at the same carbon content. The TS 81BXX series—containing the same nickel and molybdenum as the TS 80BXX but a little more chromium—is designed to have hardenability equivalent to the SAE 41XX series at the same carbon content. The TS 94B17 is designed to have hardenability equivalent to SAE 4820.

Other types of boron steels are also under investigation or in actual commercial use. The Caterpillar Tractor Co. reported several years of successful use of 14B35 (a plain carbon steel with a boron addition). Mack Manufacturing has been experimenting with 43B17 and 43BV14. Wisconsin Steel and the International Harvester Co. have created an entire new series of chromium boron steels containing 0.75-1.00% manganese, 0.40-0.60% chromium, and varying amounts of carbon. These steels were created to meet the present conditions, in which the shortage of nickel and molybdenum is much more acute than that of chromium. Some of these steels are being used in production. It is believed that 14B35, 14B50, and 14B52, and the complete 50B00 series will soon be recognized as standard compositions.

A number of full size open hearth heats of various types of boron steels have been made by the different steel companies, and have been distributed among a group of steel users for experimental trial. Results of tests of these steels have been discussed at Division VIII meetings. Further reports are still coming in. Some steel users reported difficulty in obtaining small samples of the experimental steels. It is frequently impracticable for the steel mill to roll less than the product of one ingot for any given size and type of material. It was suggested that the quickest way for the user to obtain one of the new boron steels is to change a production order already in the producer's hands. This should preferably be an order for a full heat or 100 tons or more of steel. However if several users make simultaneous requests for smaller amounts of the same type of steel, it might be possible for the steel mill to combine these orders and make a full heat of steel.

As hardenability is the main criterion used for selection of boron steels to replace other higher alloy steels, it is obvious that some specifications are needed for the hardenability of the new steels. Unfortunately it is necessary to have results from 30 to 40 production heats of steel in order to establish the width of the hardenability band within which it is practicable to control the production of the steel. This will require considerable time. However, in meantime, the steel user must be assured that each lot of steel has sufficient hardenability to respond in the usual way to production heat-treatment, and produce articles which will have satisfactory physical properties and give reliable performance in service. In general, the steel producers stated that they would be willing to furnish their customers with curves showing the actual observed hardenability of samples from each heat of steel which they supplied. It becomes the responsibility of the user that the steel is not misapplied.

Fig. 1 shows an experience hardenability band

First in Series . . .

THIS is the first article of an SAE Journal series on boron steels, based on information contributed at meetings of Division VIII—Boron Steels, of the SAE Iron and Steel Technical Committee, and edited by Harry B. Knowlton, chairman of Division VIII.

Boron steels are of vital interest to all automotive engineers and metallurgists at the present moment due to the fact that an enormous increase in the production and sale of a wide variety of civilian products in recent years, coupled with the present production of military materiel for defense purposes, has created a shortage of alloying elements used in the production of high grade automotive steels. Continued use of our present specifications for automotive alloy steels would result in an inadequate production of military materiel or a serious curtailment in the manufacture of civilian products. It has even been predicted that there may be no nickel or molybdenum steels for civilian use by September. The problem confronting the engineers and the metallurgists is a difficult and a serious one, but it is not unsolvable. During the last war the metallurgists created the National Emergency Steels and effected a considerable saving of steel making alloys, but even these steels require more alloy than is now available.

This is the problem which has been tackled by the metallurgists of the steel producing and steel consuming industries who comprise Division VIII of the ISTC. It was felt that a thorough study of the boron steels might develop information which would lead to the greatest possible conservation of alloying elements. At the first meeting of the division it was decided that the maximum interchange of information could only be accomplished by holding open meetings at which all interested parties could submit experimental data and exchange ideas. Four meetings have been held with steadily increasing attendance. Over one hundred were present at the last meeting.

This series of articles will attempt to digest the information presented at the meetings so as to make it available to all of the members of the Society of Automotive Engineers and other readers of the SAE Journal. The present article will cover general information on boron steels together with reports of users' experiences with the carburizing grades. The second article in next month's Journal will include users' reports of heat-treating grades of boron steels of various carbon contents and their use in the manufacture of bolts, steering parts, axle shafts, springs, and other automotive parts.

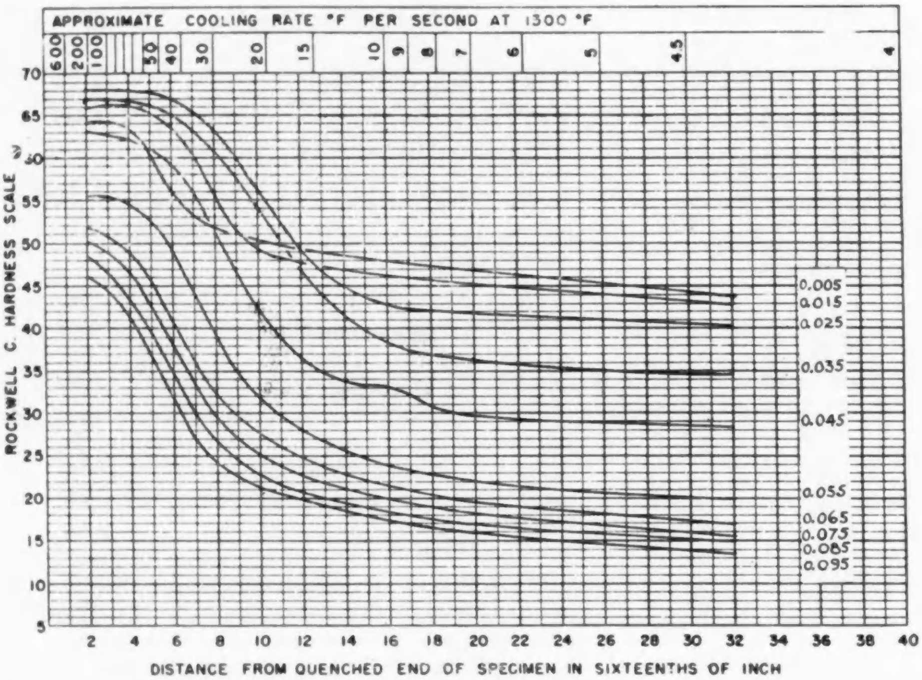

Fig. 3—End-quench test data on 80B20, heat 45128, of grain size 6-8, box carburized at 1700 F for 8 hr, cooled to 1575 F, and end-quenched. Composition was 0.205% C, 0.63% Mn, 0.019% P, 0.028% S, 0.25% Si, 0.35% Ni, 0.26% Cr, 0.12% Mo. Carbon contents at various depths below the surface were:

in.	% C	in.	% C
0.005	1.19	0.055	0.56
0.015	1.09	0.065	0.43
0.025	0.97	0.075	0.34
0.035	0.85	0.085	0.26
0.045	0.72	0.095	0.205

chart for 38 production heats of 94B20. Fig. 2 shows an observed hardenability spread for 20 production heats of 43B17 in comparison with the specifications for 4817H min and max. These bands are shown for information only. They cannot be used as specifications for acceptance and rejection.

These bands show the hardenability of the original steel and correspond with the hardenability which may be expected in the core of case hardened parts made from these steels. The hardenability of the carburized cases of boron treated carburizing steels is shown in the curves accompanying the Chrysler and International Harvester reports which follow.

In general it was noted that there was a tendency for the boron steels to show good hardenability for the first 6-8 sixteenths on the Jominy specimen; after which the hardenability drops. For example, Fig. 12 shows the hardenability of the case of a carburized specimen of 4118 steel. It will be noted that the surface shows a hardness of 63-60 Rockwell C from 1 sixteenth to 10 sixteenths from the quenched end of the Jominy specimen. A similar test on a carburized sample of 50B20 steel showed a surface hardness of 64-60 Rockwell to 6½ sixteenths on the Jominy bar. At 10 sixteenths the surface hardness was only 50 Rockwell C. This would indicate that case hardened parts made from either steel would show a minimum of 60 Rockwell C when quenched in oil after carburizing and quenching in oil, providing the section size was not more than 2⅝ in. in diameter. If the diameter was 3 in., a minimum hardness of over 60 Rockwell C would be expected with the 4118, but only 50 Rockwell with the 50B20 of the particular analysis tested.

Most investigators agree that the tendency of boron to improve the hardenability of steels varies inversely with the carbon content of the steel—that is, boron is more effective with a 0.20% carbon steel than on a 0.60% carbon, while the hardenability effect practically disappears at 0.90% carbon content. This does not mean, however, that the boron does not have any effect upon the hardenability of the case portion of carburized steels as probably better than two-thirds of the total case depth is less than 0.90% carbon, and consequently is affected to a greater or less degree by the boron. This will be discussed more thoroughly in the reports of Chrysler and International Harvester.

Most metallurgists seem to agree that some change in processing may be required when boron steels are substituted for the steels previously used. It is claimed by some that the boron steels are in some respects easier to fabricate. As compared with the other alloy steels which they will replace, the boron steels are inclined to show higher hardenability with rapid speeds of cooling, but lower hardenability with ordinary air cooling. This means that in the hot rolled, normalized or annealed condition they are likely to be softer than the steels for which they would be substituted.

Carburizing Grades of Boron Steels

Reports so far submitted to Division VIII of tests of case hardened boron steel gears indicate that these steels may be satisfactory for many case hardening applications. A warning should be given, however, that some modification of processing may be required. The chief difficulty reported with carburized boron steels has been greater distortion. It is generally believed that this is due to the fact that boron increases the hardenability of the core much more than the case. This means that during quenching, the core of the boron steel gears undergoes a more vigorous transformation in proportion to the reaction of the case, than occurs with the other alloy steels. It has also been reported that with large sections some of the boron steels do not produce satisfactory hardening of the case.

Consequently, in order to improve the hardenability of the case, and to reduce the reactions in

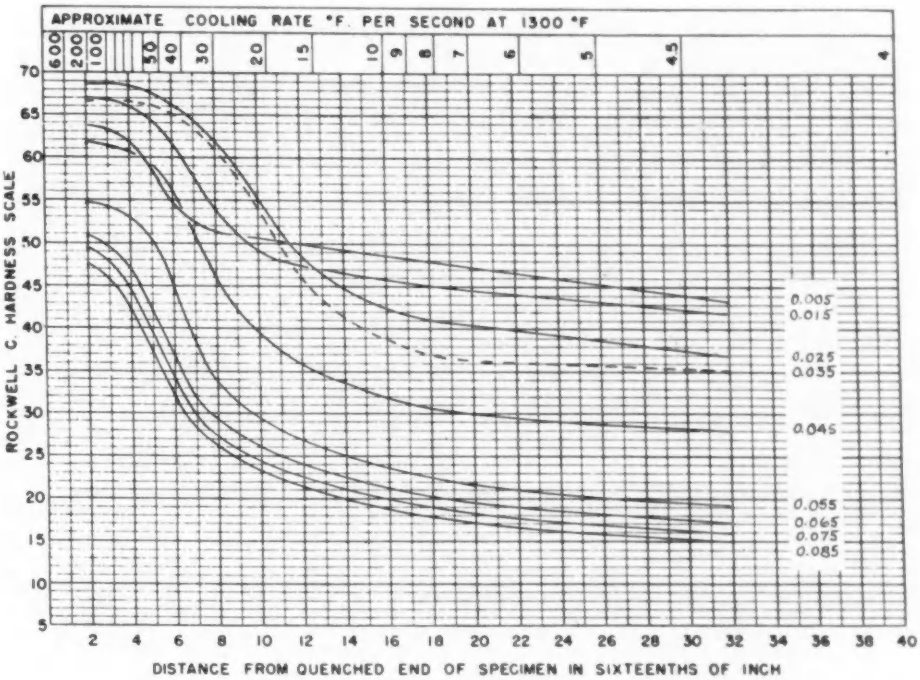

Fig. 4—End-quench test data on 80B20, heat 45128, of grain size 6-8, box carburized at 1700 F for 8 hr and end-quenched. Composition was 0.205% C, 0.63% Mn, 0.019% P, 0.028% S, 0.25% Si, 0.35% Ni, 0.26% Cr, 0.12% Mo. Carbon contents at various depths below the surface were:

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0.035	0.85	0.085	0.26
0.045	0.72	0.095	0.205

the core, the AISI made two recommendations at the SAE Division VIII June 11 meeting.

1. Raise the manganese range for 80B20 and 80B25, to 0.60-0.90%. This actually raises the hardenability of both the case and the core but is particularly recommended for the benefit of the case.

2. Add to the 80BXX series the following:

TS 80B17 with a carbon content of 0.14-0.20% and TS 80B15 having a carbon content of 0.12-0.18%.

Division VIII and other members of the ISTC present approved both recommendations by a voice vote, subject to further confirmation by letter ballot. It should be stressed that the reason for adding the two new carburizing steels is to permit the user to specify a boron steel having slightly lower carbon content than that of the steel being replaced. This means a considerable reduction in the hardenability and consequently final hardness of the core, and it is believed will reduce the distortion.

There is considerable difference of opinion among automotive metallurgists concerning the ideal properties for both case and core of carburized gears. Many metallurgists place the principal emphasis on core properties, while others feel that case properties are of greater importance. With most alloys, the addition of the alloy increases both the hardenability of the case and the core. As previously stated, with the boron steels this is not true, consequently

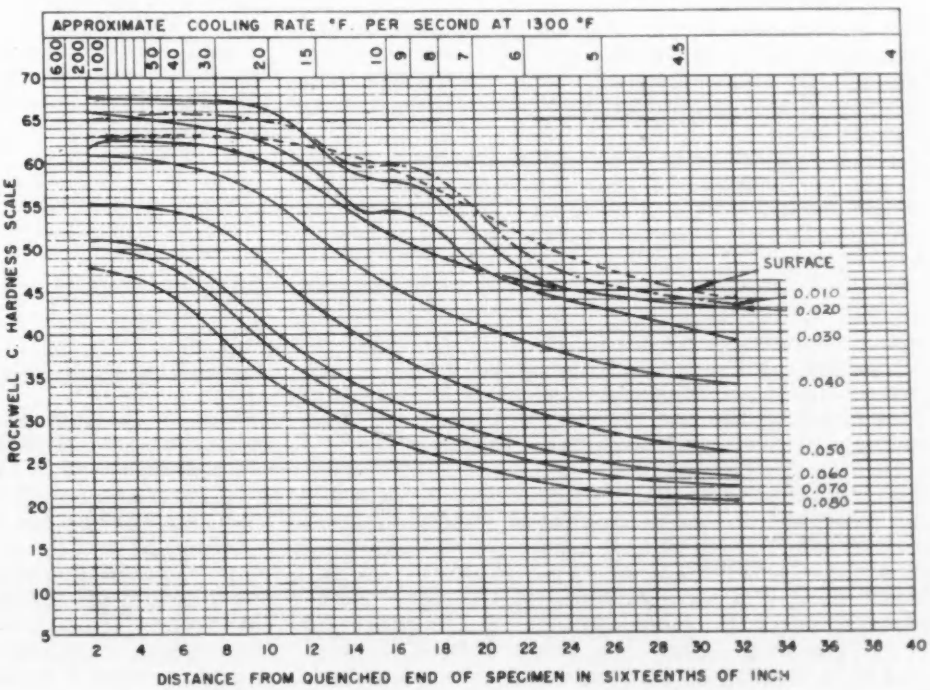

Fig. 5—End-quench test data on 94B20, heat 44725, of grain size 6-8, box carburized at 1700 F for 8 hr and end-quenched. Composition was 0.20% C, 0.85% Mn, 0.018% P, 0.021% S, 0.27% Si, 0.36% Ni, 0.44% Cr, 0.12% Mo. Carbon contents at various depths below the surface were:

in.	% C	in.	% C
surface	1.03	0.050	0.47
0.010	0.97	0.060	0.37
0.020	0.86	0.070	0.31
0.030	0.73	0.080	0.28
0.040	0.59		

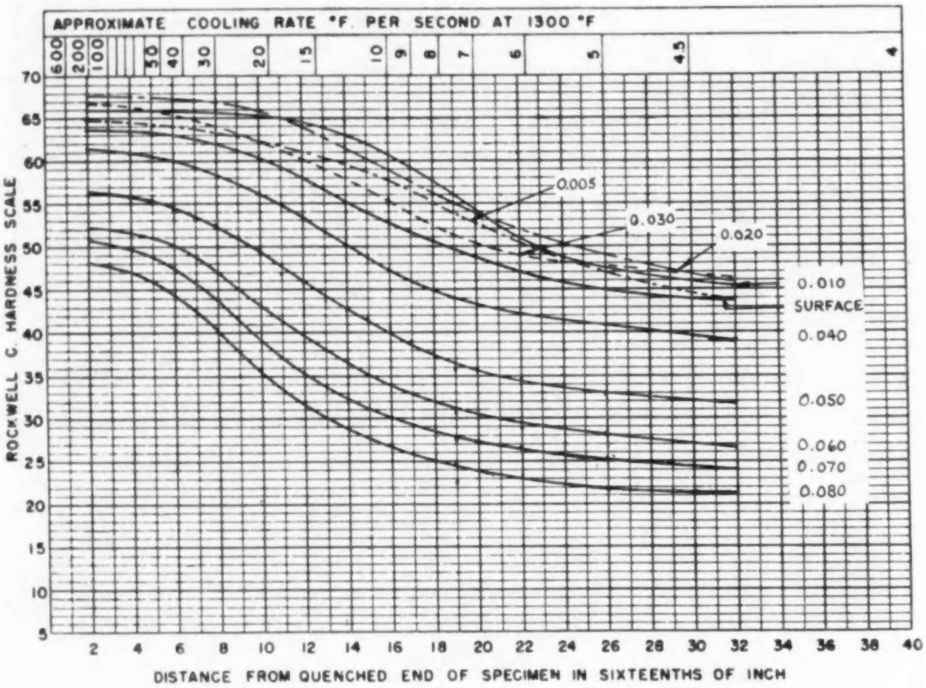

Fig. 6—End-quench test data of 94B20, heat 44725, of grain size 6-8, box carburized at 1700 F for 8 hr, cooled to 1575 F, and end-quenched. Composition was 0.20% C, 0.85% Mn, 0.018% P, 0.021% S, 0.27% Si, 0.36% Ni, 0.44% Cr, 0.12% Mo. Carbon contents at various depths below the surface were:

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0.020	0.86	0.070	0.31
0.030	0.73	0.080	0.28
0.040	0.59		

increased hardenability of the core does not guarantee any increase in the hardenability of the case.

There is also some difference in the quenching practice employed in different plants varying from direct quenching from carburizing, cooling to 1450-1600 F and quenching, to slow cooling followed by reheating and quenching. Some variations in hardenability of different steels with these several methods were reported. While discussing quenching, at least two gear manufacturers reported that martempering or quenching in hot oil produced very beneficial results with a number of steels including the boron steels.

It is felt by some that higher alloys have been used for certain case hardened gears in the past, largely because they could be quenched with the minimum amount of residual stress. Some claim that with martempering, lower alloy steels may be used with similar results.

Some specific data were presented with regard to the performance of gears made of boron steels. These looked very encouraging. Mack Manufacturing Co. has reported very good results with 43B17 for gear applications. They have also shown very good results so far as impact strength of carburized specimens is concerned. Spicer Manufacturing reported very good results with 80B20 in comparison with 8620. Timken Detroit Axle reported that the performance of their 94B17 heavy duty hypoid gears and pinions is equal, or superior, to that of 4620 on dynamometer tests.

In discussing carburizing grades of boron steels, many Division VIII participants have contributed information from the experience of their companies, including M. L. Frey of Allis-Chalmers; E. T. Bittner, American Steel Foundries; E. H. Snyder of Austin-Western; M. W. Dalrymple and J. K. Killmer of Bethlehem Steel; V. E. Hense of Buick; G. C. Riegel and F. F. Vaughn of Caterpillar Tractor; W. E. Jominy and E. H. Stilwill of Chrysler; L. E. Webb of Clark Equipment; W. J. Buechling of Copperweld Steel; T. A. Frischman of Eaton Manufacturing; Joseph Gurski, J. E. Spittle, and F. C. Young of Ford; J. H. Clark, H. B. Knowlton, and D. C. McVey of International Harvester; E. P. Kinsinger of LeTourneau; W. E. Day, Jr. of Mack Manufacturing; S. R. Hedges of Minneapolis-Moline; John Anglim of Nash; J. C. Mertz of Pratt & Whitney Aircraft; R. D. Allen and D. H. Ruhnke of Republic Steel; Robert Sergeson of Rotary Electric Steel; P. K. Zimmerman of Ryerson Steel; W. T. Groves and S. L. Widrig of Spicer Manufacturing; R. W. Roush of Timken-Detroit Axle; W. G. Bischoff of Timken Steel and Tube; P. R. Wray of U. S. Steel; H. W. Logan of Wisconsin Steel; and P. H. Booth of Youngstown Sheet and Tube.

Also, on heat-treating grades of boron steels, much information has been exchanged through Division VIII by these participants and others. Some of this information on heat-treating grades will be presented in the September SAE Journal.

Following are abridgments of some of the contributions on carburizing grades of boron steels prepared for appending to Division VIII minutes.

Data on 80B20, 94B20, 86B15, and 10T35 (now 14B35)

From W. E. Jominy of Chrysler Corp.

Figs. 3–10 show the hardenability of the four steels 80B20, 94B20, 86B15, and 10T35.

These steels were all carburized in compound at 1700 F for the period of time shown on the curves. The data for one set of curves for these steels was obtained by end quenching direct from the carburizing box at a temperature of 1700 F. The data for the other set of curves were obtained by cooling the carburizing box to 1575 F and then end-quenching the samples from this temperature. The time consumed in getting to 1575 F was about 35 min.

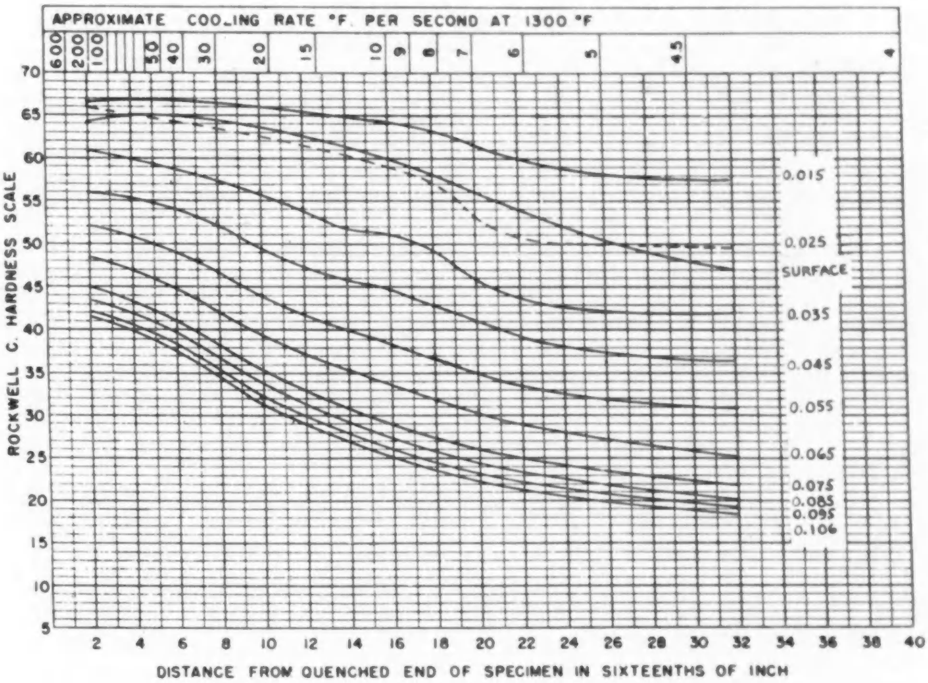

Fig 7—End-quench test data on 86B15, heat 48721, of grain size 6-8, box carburized at 1700 F for 8 hr, cooled to 1575 F, and end-quenched. Composition was 0.14% C, 0.78% Mn, 0.019% P, 0.029% S, 0.27% Si, 0.050% Ni, 0.50% Cr, 0.21% Mo. Carbon contents at various depths below the surface were:

in.	% C	in.	% C
surface	1.03	0.065	0.31
0.015	0.89	0.075	0.23
0.025	0.76	0.085	0.20
0.035	0.62	0.095	0.155
0.045	0.50	0.106	0.14
0.055	0.39		

Carbon concentration curves were obtained in this work from bars that were carburized in the same box with the hardenability bars except that these carbon concentration bars were quenched by immersing in oil and were then tempered by heating in air at 1200 F for 30 min. The surfaces of these were scratch brushed to remove any smudge and then a cut 0.002 in. deep was made and these chips examined for carbon content. Similarly, the carbon content was determined at intervals of 0.005 in. depth till a depth of 0.050 in. was reached after which carbon content was determined at intervals of 0.010 in. From the carbon concentration curves, the carbon content at any depth through the case was available. Hardness readings were taken along the length of the hardenability bar at various depths as shown on the curves and the carbon content at these depths is also listed.

The various depths were, of course, obtained by grinding flats carefully to avoid heating during the grinding operation. By this procedure, we were able to obtain the hardenability with various carbon concentrations of steel identical in composition and grain size. It will be observed from these curves that there is no loss of hardenability with increasing carbon concentration. Since there is a change in carbon concentration for each of the curves, it is of course necessary to compare hardenability by com-

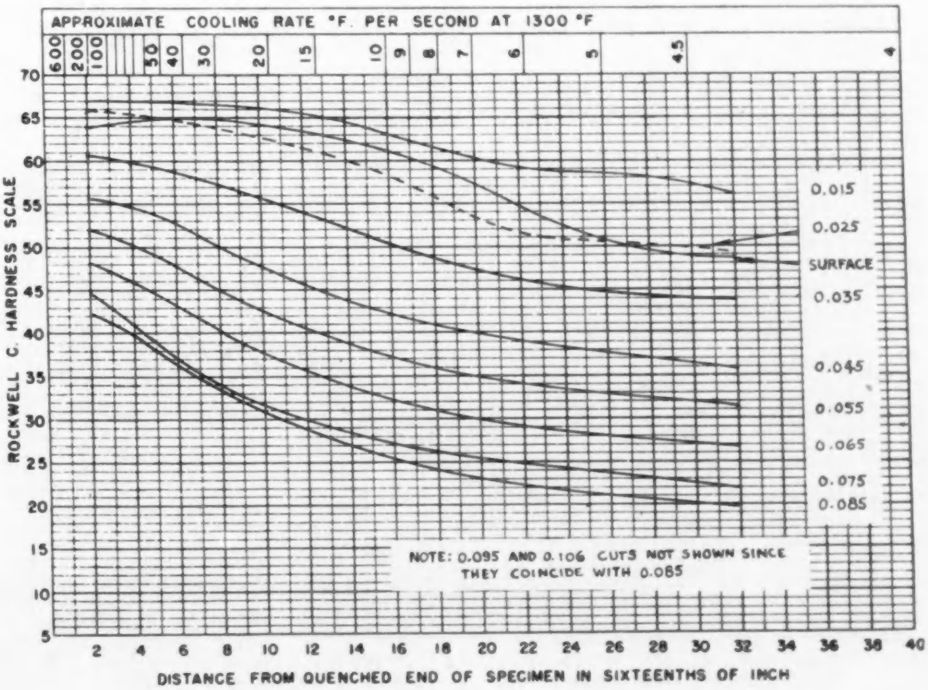

Fig. 8—End-quench test data on 86B15, heat 48721, of grain size 6-8, box carburized at 1700 F for 8 hr and end-quenched. Composition was 0.14% C, 0.78% Mn, 0.019% P, 0.029% S, 0.27% Si, 0.50% Ni, 0.50% Cr, 0.21% Mo. Carbon contents at various depths below the surface were:

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0.025	0.76	0.085	0.20
0.035	0.62	0.095	0.155
0.045	0.50	0.106	0.14
0.055	0.39		

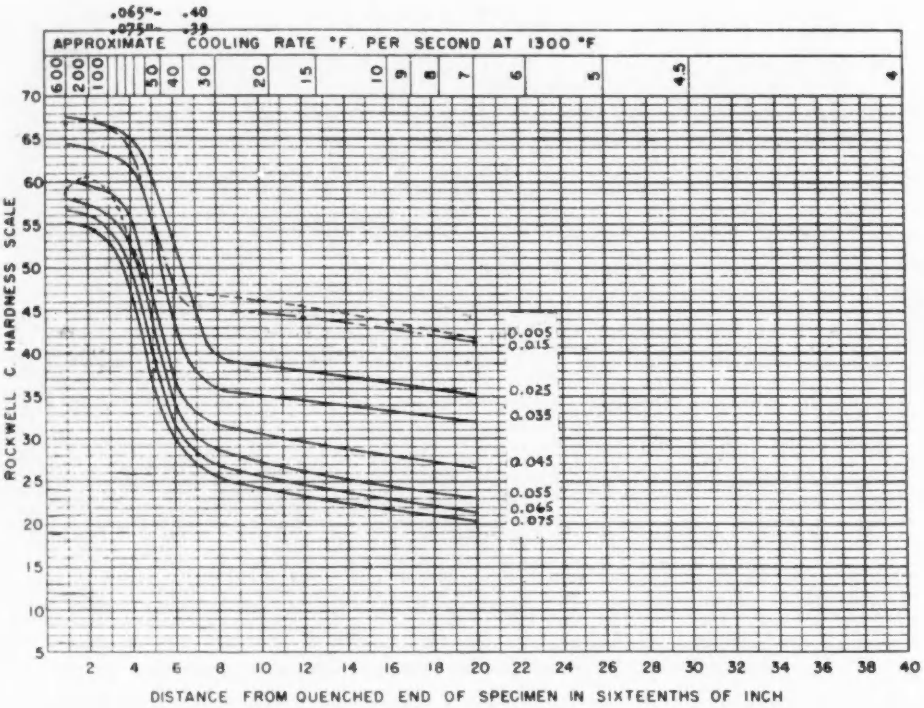

Fig. 9—End-quench test data on 10T35, of grain size 7-8, box carburized at 1700 F for 4 hr, cooled to 1575 F, and end-quenched. Composition was 0.39% C, 0.78% Mn, 0.014% P, 0.021% S, 0.20% Si, 0.12% Ni, 0.11% Cr, 0.03% Mo. Carbon contents at various depths below the surface were:

in.	% C	in.	% C
0.005	1.24	0.045	0.57
0.015	1.06	0.055	0.475
0.025	0.88	0.065	0.40
0.035	0.71	0.075	0.39

paring the distance on the end quenched bar at which the same percentage of martensite is obtained. We believe it is preferable to use a high martensite percentage such as 90% though lower percentages down to 50% may be used.

The data from these curves showing no decrease in hardenability with the increasing carbon concentration are quite encouraging for the proposed use of boron treated steels for carburizing. It is also interesting to note that no so-called fading occurred when the steels were quenched direct from the carburizing temperture of 1700 F compared to the results obtained by cooling from the carburizing temperature to 1575 F and then quenching.

I should like to voice a warning that it is necessary to take the carbon concentration into consideration in comparing hardenability curves after carburizing since carbon concentration has such a marked effect on the hardness obtained on the hardenability bars. It is also necessary to compare hardenability by determining the location of the same percentage of martensite. This can usually be done by noting the hardness which corresponds to this percentage of martensite at the carbon content under consideration.

May 17, 1951

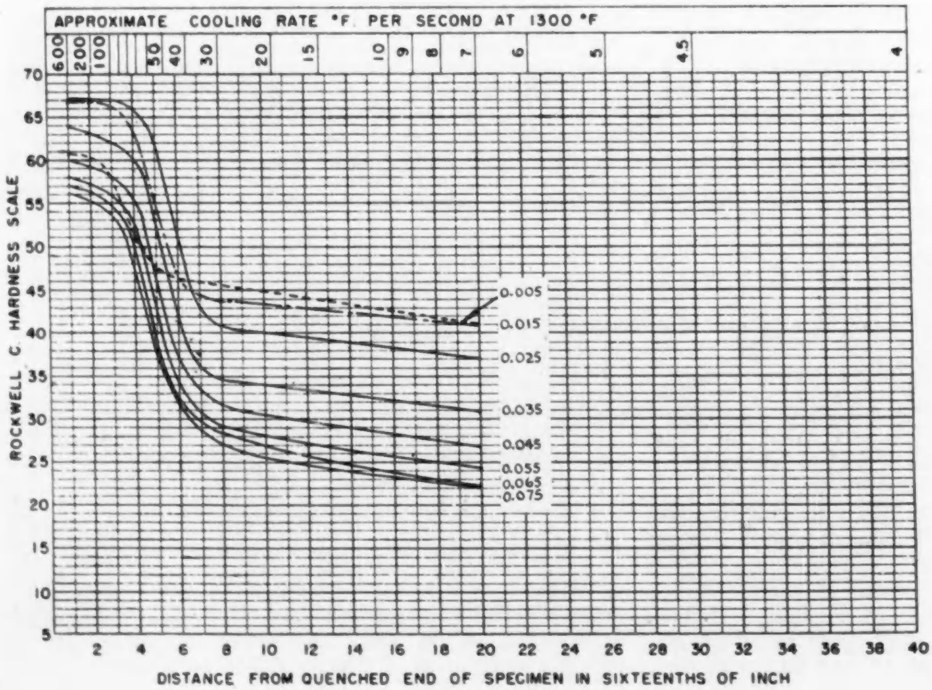

Fig. 10—End-quench test data on 10T35, of grain size 7-8, box carburized at 1700 F for 4 hr and end-quenched. Composition was 0.39% C, 0.78% Mn, 0.014% P, 0.021% S, 0.20% Si, 0.12% Ni, 0.11% Cr, 0.03% Mo. Carbon contents at various depths below the surface were:

in.	% C	in.	% C
0.005	1.24	0.045	0.57
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0.025	0.88	0.065	0.40
0.035	0.71	0.075	0.39

Report on 50B20 and 41B18 Submitted by H. B. Knowlton and D. C. McVey

Data received from McGee, Sailer, Webster, and Parish, in various Divisions of International Harvester

The steels covered are 50B20 and are not the 80B00 and 81B00 series which have been recommended for consideration by the AISI. So far we have been unable to get any trial lots of these latter steels for test. It is believed, however, that the properties of the 50B00 series are very similar to those which will be found with the 80B00 series; furthermore, that the 42B20 (41B18) steels should be of interest as a possible substitute for 4820 and other high alloy carburizing steels.

Tests have been conducted in both the Motor Truck and the Farm Tractor Divisions with case hardened boron alloy steels. In the Farm Tractor Division, tests were made with seven-pitch 50B20 steel gears in comparison with similar gears made of 8622, both carburized and hardened in the same manner. On the dynamometer, both types of gears successfully carried a bending stress of about 43,000 psi or 125% of the maximum service load without failure. Both types failed at about 52,000 psi or 150% service load. There was no significant difference in the length of life. This is illustrated in Fig. 11. Consequently, the steel tested is considered entirely satisfactory for these gears.

Tests are being made on carburized gears representing both high and low hardenability of the steel specifications, to determine the maximum size which can be carburized and quenched in oil and produce good hardness of the surface at the roots of the teeth. It is believed that if the teeth do not harden thoroughly at the surface in the roots, they will not carry satisfactory loads on the dynamometer or in service. This agrees with our experience with induction hardened gears.

As we believe that the properties of the case rather than the core of carburized gears are of maximum importance, Jominy hardenability tests were also made of 4118 and 41B18 steels after carburizing. These specimens were carburized at 1700 F, cooled to 1600 F, and then quenched in the Jominy fixture. The Jominy hardenability of the surface is shown in Figs. 12 and 13. Each specimen was then ground 0.015 in. below the surface, and new Jominy readings were taken. This was repeated after grinding 0.025 and 0.035 in. below the surface. The carbon contents at the different depths below the surface and the corresponding Jominy readings are given in the captions.

It will be noted that with the particular specimen studied, the maximum hardenability of the plain alloy steel appears at the surface, while with boron

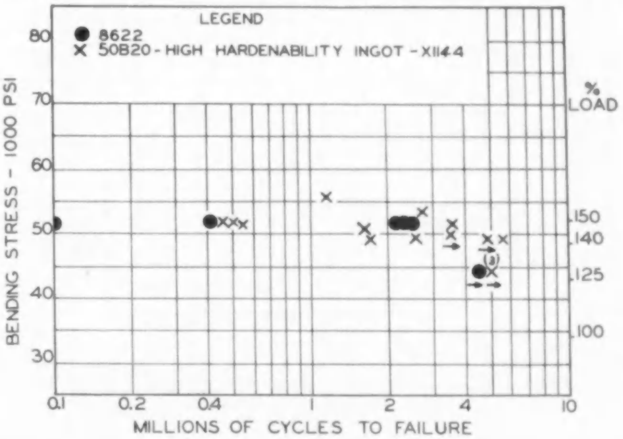

Fig. 11—Dynamometer tests on Farmall H transmission gear. Composition was 0.23% C, 0.84% Mn, 0.23% Si, 0.22% Ni, 0.48% Cr, and 0% Mo, with Grainal 79 added. Data are from IH Manufacturing Research and IH Farmall Works

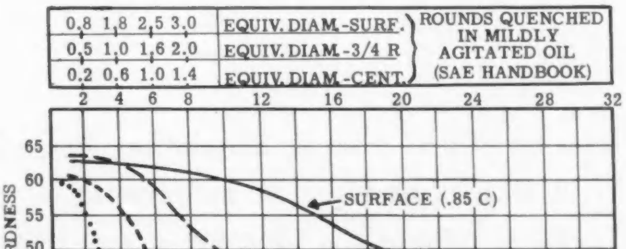

Fig. 12—Hardenability of SAE 4118 determined on carburized Jominy specimens at surface, 0.015 in. below, 0.025 in. below, and 0.035 in. below. Grain size was 7. Composition was 0.22% C, 0.82% Mn, 0.22% Si, 0.28% Ni, 0.55% Cr, 0.13% Mo. Box carburized at 1700 F, cooled in box to 1600 F, and end quenched. Data are from Sailer, IH EMRT Laboratory

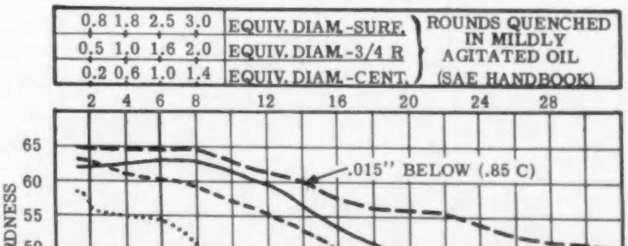

Fig. 13—Hardenability of 41B18 determined on carburized Jominy specimens at surface, 0.015 in. below, 0.025 in. below, and 0.035 in. below. Grain size was 7. Composition was 0.22% C, 0.90% Mn, 0.25% Si, 0.22% Ni, 0.45% Cr, 0.15% Mo. Box carburized at 1700 F, cooled in box to 1600 F, and end quenched. Data are from Sailer, IH EMRT Laboratory

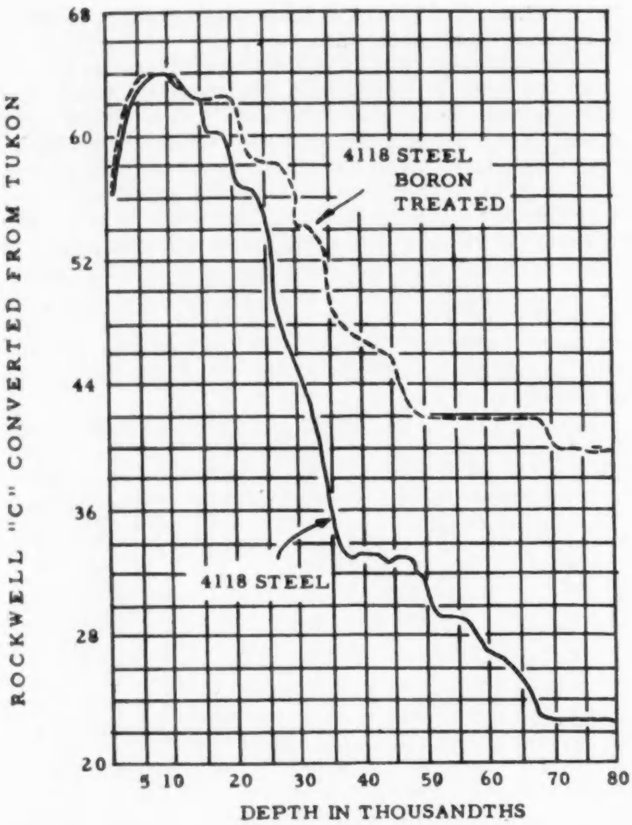

Fig. 14—Pitch line hardness gradient for carburized and mar-quenched IH L-170 truck rear axle pinions made from 4118 and 41B18 steels. Data are from D. A. Webster

Fig. 15—Pseudo-carburized tensile and impact specimens of AISI 80B20 steel of Republic heat 45128. Specimens at left were pseudo-carburized for 10 hr at 1700 F, cooled to 1450 F in 1½ hr, held at 1450 for 4½ hr, and oil quenched. Specimens at right were pseudo-carburized 10 hr at 1700 F, cooled to 1550 F in ¾ hr, held at 1550 F for 5¼ hr, and oil quenched

alloy steels the layer 0.015 in. below the surface shows higher hardenability than the surface. This correlates with previously published data showing that the effect of boron on hardenability increases with decrease of carbon content.

It is frequently true, however, that the hardness of the surface of case hardened alloy steels is less than that of the layer 0.015 in. below. Sometimes the hardenability curves of the two zones cross. Variations in results may be due to differences in carbon content, tendencies toward decarburization, and presence of retained austenite.

The statement which is so frequently heard, that boron does not have any effect on the hardenability of the case, does not seem to be correct, except for the extreme outer surface. At a depth of 0.015 in. below the surface, boron does seem to have an effect upon the hardenability. This may be of practical significance.

In the Motor Truck Division, experiments were conducted with 4118 steel, with and without boron to see if a satisfactory substitute for 4820 could be produced. Fig. 14 shows the results of hardness readings taken on the cross sections of gear teeth. It will be noted that there is little or no difference in the cross sectional hardness of the steels with and without boron for the first 0.015 in. below the surface, but from that point on, the boron steel does have an advantage. One of the definitions for "effective case" is the distance from the surface to a point corresponding to 50 Rockwell C. On this basis the effective case of the 4118 steel is about 0.027 in., while the effective case of the 41B18 is 0.035 in. This is probably due to increased hardenability, not to increased carburization.

Dynamometer tests in the Motor Truck Division have indicated that lower alloy steels with the benefit of marquenching may give as good performance as higher alloy steels with conventional oil quenching. This may be of particular significance in the consideration of the use of boron treated steels.

May 2, 1951

Data on 80B20 from B. L. Johnson, Jr. and W. E. Day, Jr. of Mack Manufacturing

A 2⅝ in. diameter hot rolled bar of AISI 80B20 steel from Heat 45128 was received from the Republic Steel Co. for test purposes. The boron addition to this heat was 4 lb per ton of Grainal No. 79. The mill analysis was 0.205% C, 0.63% Mn, 0.019% P, 0.028% S, 0.25% Si, 0.35% Ni, 0.26% Cr, and 0.12% Mo. Table 1 gives the hardenability data.

Tensile and impact specimens were machined after forging the bar down to 1¼ in. diameter. The specimens were pseudo-carburized for 10 hr at 1700 F, then cooled to either 1450 or 1550 F and held at the lower temperature to give a total heat-treating time of 16 hr before oil quenching. Duplicate specimens were tested in each case, and a repeat run was subsequently made on the treatment having the 1450 F quenching temperature.

The results of the physical test on the pseudo-carburized specimens are given in Table 2. Extreme

brittleness was evident in the specimens quenched from 1450 F, whereas the specimens quenched from 1550 F broke in a normal ductile manner. Fig. 15 compares tensile and impact fractures on specimens quenched from 1450 and 1550 F. It was also observed that the tensile specimens quenched from 1450 F had a different stress-strain relationship within the usual elastic range than those quenched from 1550 F. Typical curves are plotted in Fig. 16, where it will be noted that the specimen quenched from 1450 F shows an appreciable deviation from Hooke's law even at fairly low values of stress, and the apparent modulus of elasticity is considerably lower than the expected value for steel.

The microstructures of the pseudo-carburized tensile specimens and of the hot rolled bar from which they were made are shown in Figs. 17, 18, and 19. It is evident that heating at 1700 F has produced extreme grain coarsening in this steel. It should also be noted that the specimen quenched from 1450 F has a considerable amount of proeutectoid ferrite in the structure and that rupture appears to have occurred preferentially in these areas during the tensile test. It is believed that this phenomenon of localized failure occurring within the ferrite grains at relatively low stress levels has produced

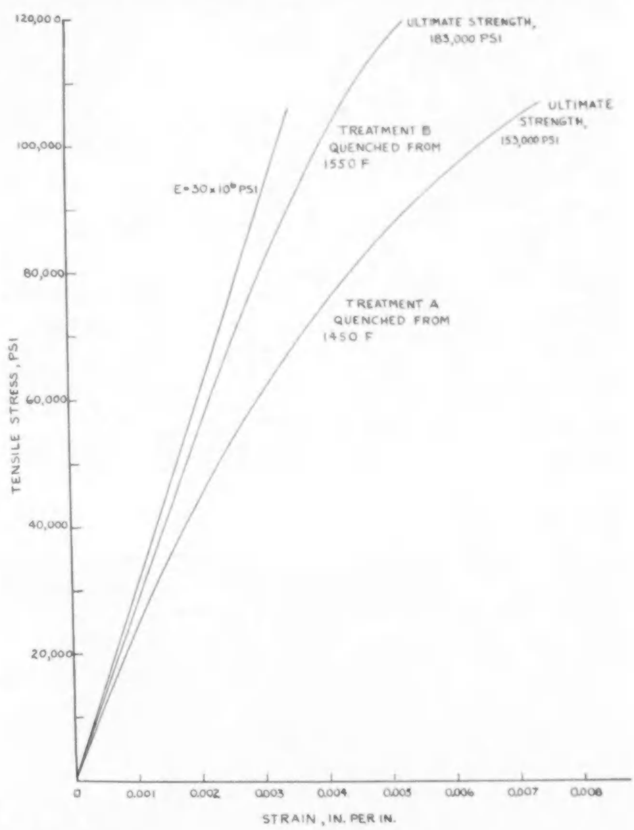

Fig. 16— Stress-strain diagram for TS 80B20, Republic heat 45128

Table 1—Jominy Hardenability of a 2½-in. Diameter Hot-Rolled Bar of 80B20, Republic Heat 45128, Normalized at 1700 F and End Quenched from 1700 F

16ths	1	2	4	6	8	10	12	14	16	20	24
Rc	44	44	42	34	25	21	20	18	16	14	11

Table 2—Properties of Pseudo-Carburized 80B20 Steel Specimens Machined from a 1¼-in. Diameter Bar Which Was Forged from a 2½-in. Diameter Hot-Rolled Bar

Treatment A: Heated at 1700 F for 10 hr, cooled to 1450 F in 1½ hr, held at 1450 F 4½ hr, and oil quenched
Treatment B: Heated at 1700 F for 10 hr, cooled to 1550 F in ¾ hr, held at 1550 F 5¼ hr, and oil quenched

Treatment	Yield Strength 0.2% Offset, psi	Ultimate Strength psi	Elongation % in 2 in.	Reduction in Area, %	Hardness, Rc	ASTM Grain Size	V-Notch Charpy, ft-lb	Hardness Rc
A	93,000 85,400	153,000 153,000	6½ –	14 5½	31 32	2	11 11½	33 36
A Repeat	81,700 86,300	144,600 147,000	4½ 5	10 10½	31 32	2	12½ 13½	36 36
B	144,000 137,700	186,000 182,800	14½ 13	50 49	40 29	2	44 46	41 41

Table 3—Properties of Carburized 80B20 Steel

Treatment A: Pack-carburized in coke and dolomite compound for 10 hr at 1700 F, cooled to 1450 F in 1½ hr, held at 1450 F for 4½ hr, oil quenched, and tempered 1 hr at 325-350 F
Treatment C: Gas-carburized in R-X gas and propane for 13 hr at 1700 F, cooled to 1525 F in 1½ hr, oil quenched, and tempered 1 hr at 325 F

Treatment	Unnotched Charpy Impact, ft-lb	Rc Hardness Case	Rc Hardness Core	Case Depth, in.	% C in Case 1st 0.005 in.	% C in Case 2nd 0.005 in.
A	17 19½	64 64	39 39	0.065	0.84	0.78
A Repeat	24 28½	63 63	41 41	0.065	0.77	0.74
C	16½ 16	64½ 64½	39 40	0.060	1.00	0.84

Table 4—Chemical Compositions of Steels Investigated

	C, %	Mn, %	P, %	S, %	Si, %	Ni, %	Cr, %	Mo, %	B, %
43B17 Beth. 7t elec. Ht. AX4744	0.19	0.53	0.010	0.008	0.221	1.87	0.48	0.26	
43B17 Beth. 43t elec. Ht. 23A778	0.18	0.48	0.021	0.014	0.31	1.79	0.45	0.24	
43B17 Repub. 100t O.H. Ht. 44588	0.165	0.55	0.018	0.027	0.25	1.72	0.45	0.25	
43B17 Repub. 100t O.H. Ht. 44651	0.14	0.45	0.04	0.04	0.20	1.65	0.35	0.20	
46B20 Carnegie-Ill. Superkore B-Ht. 2C0831	0.18	0.76	0.020	0.042	0.28	1.86		0.23	0.0022
4820 H Bar Stock Ht. 48185	0.20	0.68	0.025	0.012	0.29	3.50	0.17	0.26	
4820 Bar Stock Ht. 44311 N.B.	0.20	0.61	0.015	0.012	0.23	3.31	0.23	0.25	
94B20 Wisconsin Ht. X525	0.25	1.03	0.011	0.021	0.48	0.30	0.28	0.16	

Table 5—Data on Pseudo-Carburized Specimens

Steel	0.2% Offset Yield Strength, psi	Tensile Strength psi	% Elongation in 2 in.	% Reduction in Area	Tensile Rc
43B17 Beth. 7t elec. Ht. AX4744	157,000 154,000	198,000 198,000	15½ 15	56.9 58.2	40 40
43B17 Beth. 43t elec. Ht. 23A778	144,000 147,000	187,000 193,000	12½ 13	43.2 46.2	39 41
43B17 Repub. 100t O.H. Ht. 44588	146,000 149,000	192,000 196,000	15 15	60.1 57.1	44 42
43B17 Repub. 100t O.H. Ht. 44651	141,000 145,000	186,000 187,000	12½ 13½	45.2 49.3	42 41
46B20 Carnegie-Ill. Superkore B	145,000 147,000	193,000 193,000	14 14	50.8 51.9	41 41
4820 H Bar Stock Ht. 48185	168,800 166,600	213,500 213,500	13 14	45.0 45.6	43 43
4820 Bar Stock Ht. 44311 N.B.	160,000 165,000	192,750 207,075	15 14	53.8 47.5	46 45
94B20 Wisconsin Ht. X525	160,000 164,000	223,000 222,000	13.8 12.5	44.7 46.9	47 46

the unusual stress-strain relationship which was observed in this case. Similar tests which have been run in this laboratory on AISI C 1020 and 43B17 steels, purposely quenched from below the upper critical temperature so as to precipitate proeutectoid ferrite, have shown only slight loss in ductility compared to the 80B20 steel and the modulus of elasticity was unaffected. However, in those cases the grain size remained fine, and it is believed that the extreme effects observed in the subject heat of 80B20 steel when quenched from 1450 F are caused by the combination of large grain size and heterogeneous microstructure.

The results of unnotched Charpy impact tests on carburized specimens are given in Table 3. Two carburizing treatments were used, one a pack carburizing treatment with a special compound designed to produce a low carbon case, and the other a gas carburizing treatment with a mixture of combusted gas and propane, which was also intended for low carbon case but which in this instance did not function as intended. A repeat run was made on the pack carburizing treatment, which produced a surface carbon somewhat lower than the initial run. The impact strength listed in Table 3 shows an inverse relationship with surface carbon, being higher with

lower carbon content.

On the basis of many similar impact tests run on carburized specimens of other steels, it was found that the poor core properties obtained with the subject heat of 80B20 steel when quenched from 1450 F had very little effect on the impact strength of the carburized Charpy specimens. This is in agreement with our previous observation that the impact strength of carburized unnotched Charpy specimens is primarily dependent on the properties of the case and in particular on the carbon content within 0.010 in. of the surface. However, it should be kept in mind that in larger sections, where the ratio of case area to core area is lower than in the Charpy specimen, the effect of core properties would probably be more noticeable.

With regard to the large grain size developed in this heat of steel upon heating at 1700 F, it should be pointed out that the boron addition was made in the form of Grainal No. 79, which contains no vanadium. In view of experience with other boron treated steels indicating that the presence of vanadium suppresses the apparent grain coarsening tendency of boron, the possibility should be considered of improving the properties of 80B20 steel by the use of a vanadium bearing boron addition such as Grainal No. 1.

May 14, 1951

Data on 43B17, 46B20, and 94B20 From W. E. Day, Jr. of Mack Manufacturing

Fifty tons of heavy-duty countershaft production parts made from 43B17 which replaces 4820 have been in service for five years. During that period there were no failures from 43B17 but two failures occurred in parts made from 4820.

The accompanying data were derived from tests on five heats of boron-treated steels of carburizing grade. These heats consisted of two open-hearth heats of 43B17, two electric heats of the same grade, and one open-hearth heat of 46B20.

Data comprise end-quenched hardenability tests of pseudo-carburized tensile pieces, Charpy tests on V-notched bars pseudo-carburized, and tests on unnotched carburized Charpy bars of varying surface carbon content tested at room temperature.

Tensile and Charpy V-notch tests on pseudo-carburized and hardened pieces were made from each heat in Table 4, including the two lots of 4820 H for comparison. These results are listed in Table 5.

In Fig. 20, the effects of surface carbon concentration on hardness and impact value are shown. Specimens for these tests were taken from the first three heats of 43B17 and the first heat of 4820 in Table 4. The degree of surface carbon concentration was obtained by varying diffusion times and temperatures after the initial carburizing at 1700 F, and by use of carburizing compounds having various carbon potentials. The specimens were, for the greater part, box carburized, a few being gas carburized, and the carbons shown are the averages of the first two cuts of 0.005 in. each. All test pieces were finish ground to size before heat-treating, carburized to approximately 0.060 in. case depth and drawn at 325–350 F for 1 hr after direct quenching from 1450 F.

It has been our observation that when box carbur-

Fig. 17—Pseudo-carburized tensile specimen quenched from 1450 F. Specimen given nital etch and photographed at 100 times magnification

Fig. 18—Pseudo-carburized tensile specimen quenched from 1550 F. Specimen given HCl-picral etch and photographed at 100 times magnification

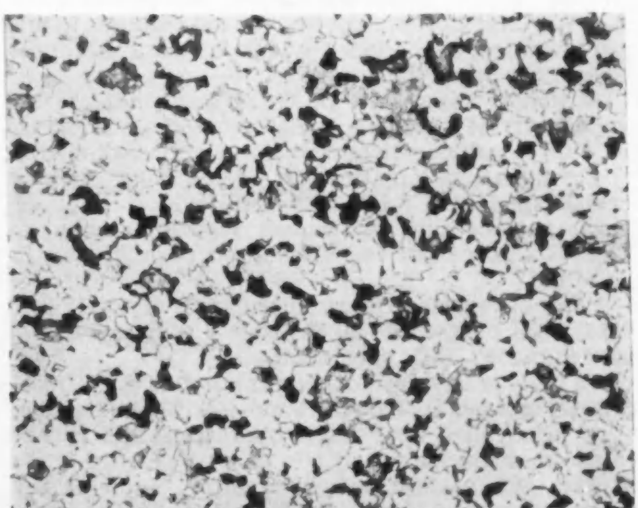

Fig 19—Section from hot rolled 2⅝ in. diameter bar given nital etch and photographed at 100 times magnification

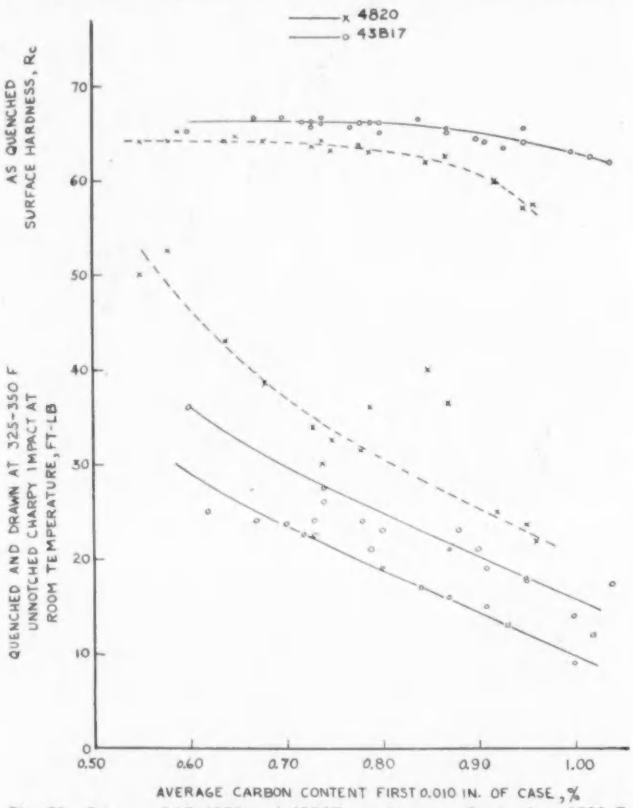

Fig. 20—Data on SAE 4820 and 43B17 specimens carburized at 1700 F, cooled to 1450 F, and oil quenched. Case depth was 0.060 in. Core hardness was Rc 40-44

izing in the conventional manner at 1700 F and permitting the temperature to drop at end of heat to 1450 F followed by direct quenching, 4820 will show a surface carbon of slightly below 1.00% while in 43B17 it is slightly above this value for case depths of approximately 0.060 in. Further, the impact resistance of the carburized unnotched Charpy bar increases as the surface carbon decreases. The surface hardness likewise increased as the carbon decreased to some 0.80% C in 43B17 and to 0.70% C in 4820. It then remained constant to approximately 0.60% C and perhaps lower. These changes in impact values were independent of core hardness, which ran from 40Rc to 44Rc.

Although the results of these tests indicate the superiority of 4820 over 43B17 from the standpoint of impact values when carburized and hardened in the conventional manner, it seems clear that by carburizing 43B17 by a method which produces lower surface carbons, impact resistance equal to that of 4820 carburized by general practice can be obtained.

A few carburized Charpy bars, both of 43B17 and 4820, were broken at -20 F. A loss of 4 to 10 ft-lb was found in both specifications.

We believe that use of the unnotched carburized Charpy test bar introduces a more critical condition than exists in a gear tooth because of the corner effect in carburizing and the lack of radii of these corners which exist on gear teeth. Much of the scatter in impact values for the 43B17 steel is probably attributable to variation in carbide build-up at the corners of the specimen resulting from different carburizing treatments.

Due to the apparent tendency of the boron-treated steels of carburizing grade to show high high-side hardenability, we believe that the carbon range should be 0.10%-0.16%, and vanadium content of 0.03-0.08% should be maintained as an aid in controlling this condition. Unless high-side hardenability is held to approximately J44 = 1/4 in. or perhaps slightly lower, gear tooth distortion is likely to be encountered in gears above three or four pitch.

March, 1951

Data on 43B10 from J. C. Mertz Of Pratt & Whitney Aircraft

Response of AMS 6266 (43B10) steel to carburizing and heat-treatment was determined using bars and billets from a five-ton electric furnace heat produced by Carnegie-Illinois Steel Corporation. Comparison was made with the characteristics of AMS 6260 (SAE 9310) steel as shown in Tables 6-9. Included are data on mechanical properties obtained by the producer on the same heat of AMS 6266 steel. Critical temperatures as determined by the producer were 1292 F and 1544 F on heating and 1050 F and 662 F on cooling.

Carburizing tests were performed in production gas-carburizing equipment at 1700 F, using both continuous (Westinghouse) and batch (Homocarb) furnaces. The continuous carburizing cycle consisted of 7½ hr at heat followed by a relatively fast cooling in the furnace atmosphere; the batch carburizing cycle consisted of 5½ hr at heat followed by relatively slow pit cooling.

Heat treatments for machinability during processing of AMS 6266 are similar to those used for AMS 6260; forgings are normalized and tempered to a hardness range of Brinell 229-269, and parts requiring machining of carburized areas prior to hardening are tempered to reduce the case hardness to not over Rockwell C 36. For final heat-treatment, AMS 6266 parts are austenitized at 1550-1600 F, quenched in oil and tempered at 300 F.

It was found that carburizing and heat-treating characteristics of AMS 6266 steel differed only in minor degree from those of high-hardenability carburizing grades not treated with boron. Diffusion of carbon in AMS 6266 steel was somewhat greater than in AMS 6260 steel. This was reflected in lower maximum carbon content with resultant decrease in amount of retained austinite and massive carbides. Carburized AMS 6266 steel showed a somewhat greater tendency to decarburize in subsequent heat-treatments than did carburized AMS 6260 steel.

Several highly stressed parts such as gears, shafts, and couplings have been manufactured from AMS 6266 forgings and bars. Machinability has been found to be similar to that of AMS 6260 steel. Response to carburizing and heat-treatment have been satisfactory, with distortion of parts very similar in amount and character to that of AMS 6260 steel parts. Cold treatment of AMS 6266 steel parts has not been found necessary in order to meet minimum case hardness requirements; such treatment is occasionally necessary with AMS 6260 steel parts. Engine service records of the AMS 6266 steel parts have been highly satisfactory.

March, 1951

Table 6—Chemical Analyses

Steel	Heat	C, %	Mn, %	Si, %	Ni, %	Cr, %	Mo, %	V, %	B, %
AMS 6266 Steel	Carnegie, ACX 12463	0.14	0.83	0.35	1.76	0.50	0.29	0.05	0.003[a]
AMS 6266	——	0.08 0.13	0.75 1.00	0.20 0.40	1.65 2.00	0.40 0.60	0.20 0.30	0.03 0.08	0.001 0.007
AMS 6260 Steel	Carpenter X-68002	0.11	0.58	0.30	3.53	1.60	0.07	—	—
AMS 6260	——	0.07 0.13	0.40 0.70	0.20 0.35	3.00 3.50	1.00 1.40	0.08 0.15	— —	— —

[a] Carnegie-Illinois analysis on same heat.

Table 7—Jominy End-Quench Hardenability

Steel[a]	ASTM Grain Size		Distance From Quenched End (Sixteenths inch) 1	2	4	6	8	12	16	20	24	28	32
AMS 6266[b]	5-7	Rc	40	40	40	39.5	39	38	37	35	33	31	28.5
AMS 6266 requirement[c]		J	41 max	—	—	—	35 min	—	—	—	—	—	—
AMS 6260	7	Rc	41	41	40.5	40	40	39	38.5	38	37.5	37	37
AMS 6260 requirement		J	41 max	—	—	32 min	—	—	—	—	—	—	—

[a] Both steels normalized at 1700 F; AMS 6266 steel austenitized at 1600 F and AMS 6260 steel austenitized at 1500 F.
[b] Average of specimens from top and bottom of ingot.
[c] AMS 6266 requires normalizing at 170 F and austenitizing at 1555 F.

Table 8—Case Depth at 0.25% Carbon and Maximum Carbon Contents

Steel	Type of Carburization	Carburizing Time and Temperature	Case Depth, in.	Maximum Carbon Content
AMS 6266	Continuous	1700 F (7½ hr)	0.061	0.84% (0.003 in. beneath surface)
AMS 6260	Continuous	1700 F (7½ hr)	0.053	0.84 (0.005 in. beneath surface)
AMS 6266	Homocarb	1700 F (5½ hr)	0.065	1.08 (0.008 in. beneath surface)
AMS 6260	Homocarb	1700 F (5½ hr)	0.058	1.25 (0.003 in. beneath surface)

Table 9—Case Hardness, Rockwell A

Steel and Type of Carburization	As Carburized	Carburized and after Tempering at 1200 F for 2 Hr	Direct Quench			Reheat (1600 F) and Quench		
			As Quenched	300 F Temper	Core (Rc)	As Quenched	300 F Temper	Core (Rc)
AMS 6266 Continuous	74-78	69.5-70.5	83-84	82.5-83	37-38	83.5-84.5	81-83	37-39
AMS 6260 Continuous	77.5-78.5	72-73.5	82-84	80.5-81.5	37-38	80.5-82	78.5-81	37-39
AMS 6266 Homocarb	69-72	67-69.5	77-80	79.5	34-39	82-82.5	80.5-81.5	37-39
AMS 6260[a] Homocarb	65.5-72	77-78	65-74.5	64-65	34.5-38	79-82.5	79	37-39

[a] Variable hardnesses were due to excessive amount of retained austenite. AMS 6260 steel showed greater retention of austenite and undissolved carbides regardless of type of carburization.

Table 10—Core Mechanical Properties, AMS 6266 Steel[a]

Pseudo Carburized	Quench Temperature, F	Quench Medium	Tempering Temperature, F	Tensile Strength, psi	Yield Strength, psi	% Elongation	% Reduction in Area	Izod Impact, ft-lb
1700 F (8 hr)	Direct Quench	Oil	350	166,250-169,000	116,000-120,000	15.0-16.0	54.9-58.8	49-51
1700 F (8 hr)	1575	Oil	350	179,250-188,000	119,000-125,500	14.5-15.5	53.8-54.9	36-38
1700 F (8 hr)	1525	Oil	350	182,750-184,500	123,400-125,500	15.0	52.5-53.6	34-36

[a] Carnegie-Illinois data from heat ACX 12463.

In this article, a top technical executive gives advice to people and solutions to problems as seen through the eyes of engineering management

How to Make Good

AS ENGINEERS, all of us are proud of our profession. We want our efforts to be effective, and we want our contributions to be felt and recognized. In this day of large companies, however, the only way most of us can achieve this goal is to be a part of a successful organization—and that means one that is properly managed. So, to the many other abilities and aptitudes required in the engineering profession, we must add the element of good management as a prerequisite to success.

A corporation is no better than its product, and its product is no better than the engineering department. When engineering is not properly managed, the product suffers. The result is loss of prestige of the engineering department, a growing indifference on the part of the company toward engineering, and the eventual deterioration of the company itself through the lack of an adequate engineering program. Whether or not they hold top positions in engineering management, all professionally-minded engineers have a stake in management and are in a position to make a contribution to it.

Sometimes, engineers—particularly in the larger organizations—tend to develop an indifference to the operation of management and its problems because they are isolated and protected by strong personalities at the top of the engineering organization. They are accustomed to letting these top men shelter them from management considerations, do all their arguing and fighting for them with other parts of the corporation, and bailing them out when they get into trouble. Engineers in such organizations never get a chance to develop management ability, and when the time comes to pick a man for a top job there is no one available.

Only by being exposed to actual management situations does the real temper of a man come out. I recall being told by a certain executive that even after he became president of his company and was in complete charge of its operations, he still felt aided and supported by the presence of the chairman of the board in the background even though the chairman wasn't around very much. He was always there for counsel if necessary. It was only after the chairman of the board passed away that he first felt completely on his own—and in a large corporation that can be an awesome feeling.

So it is in engineering management after a man reaches the top and no longer has anyone to turn to for support. He is entirely on his own in making his decisions and standing by them himself. He in turn, has become the support for the men under him.

An engineering executive must not only do a sound job of engineering, but he must also analyze everything in terms of how the corporation management will look upon it. He must spot weaknesses before his superiors do. He must be prepared to defend and explain the reason for every action.

A good executive is not supposed to be concerned with details—the dotting of the i's and crossing of the t's. He can't attend all the meetings and be in on every minor decision. The job is too big. He must delegate responsibility.

On the other hand, any one of the men over the executive may become acquainted with some detail on which he can raise a question and expect the executive to be familiar with it. If he is not, he is apt to give the impression that he is not on his toes . . . that he is out of touch with the operation he is supposed to be directing. So each executive must fix his own dividing line between avoiding too many details and still being able to talk on any question his superiors may raise.

An engineering operation becomes successful only as it is an integral part of its corporation—working in harmony with all the other corporate elements. To achieve this integration, engineering management must broaden its outlook beyond the scope of purely engineering problems and develop a satis-

in Engineering

EXCERPTS FROM PAPER BY

James C. Zeder, Vice-President and Director of Engineering, Chrysler Corp.

• Paper, "Some Observations on Engineering Management" was presented at the Akron-Canton District of SAE Cleveland Section, April 9, 1951.

factory relationship with manufacturing and sales and finance.

Since engineering management must be concerned to a certain degree with the problems of sales, finance, manufacturing, advertising, and service, it is only natural to expect that these other divisions of the company will also concern themselves with engineering problems. This inevitably leads to the other divisions having ideas on how the engineering should be done. There is no law that good ideas can happen only to engineers.

Furthermore, you want to keep the other divisions as your friends and retain their cooperation. So you must always be willing to make an immediate analysis of any suggestions they advance. If the idea isn't usuable, then tactfully and politely present information which will let them convince themselves of that fact. Thus, you earn their respect by being courteous enough to consider their suggestions, and sometimes you may get an idea that is really of value to you. Also, this tends to keep an engineering department on its toes . . . to keep it constantly trying to think of all possible ways to do a thing before anybody else does.

Certain engineering executives never accept this principle and are impatient of working with the other divisions on a give and take basis. As a consequence, they place a ceiling on their own progress. As an engineer is given increased responsibility, his contacts spread more and more outside the engineering department. And, outside he is judged more as a co-worker and as a human being than as an engineer. Such a man can be an excellent engineer, but if he is not acceptable to people in the other divisions, there is a limit to how far he can be raised. An engineering manager might be able to handle him and lean very heavily on him, but not be able to give him a bigger job because of the poor relationships which he would engender with the other divisions. Those who aspire to high positions in engineering management should learn early the necessity for engineering to mesh smoothly with the rest of the corporation.

Engineering management's main job is to get best results from the men, money, and equipment with which it has to work. Many misconceptions exist about what constitutes good management in this respect. Some feel that when they have worked out the assignment of responsibilities and the flow of operations on an organization chart, 90% of the job is done. Others feel that creation of forms and establishment of procedures and methods are the core of the management job. While all of these things are important, they actually constitute only the visible outline—the superficial aspects—of management. They are not what really makes an organization work smoothly and efficiently.

The things that really count in good management are the ones you can't put in an organization chart . . . the feelings and attitudes which men have within themselves about their jobs and their organization.

Do they have a feeling of loyalty to their company? Does each man feel he has a definite place in the organization; that he is a member of a team working on a job of great importance both to the company and to society? Does he feel he has a definite stake in the organization . . . its success or failure? These are the questions which determine whether your organization will do an ordinary, run-of-the-mill job, or whether it will be constantly up on its toes, vibrating with enthusiasm and new ideas, and hammering out a brilliant job of engineering. This is the true measure of good management, regardless of the organization chart.

To achieve this kind of management, you must have an understanding of people. Most important to your organization structure is your executive group. By that I mean engineering department heads, chief engineers, and the like. If there is any weakness in that structure, it cannot be bolstered

Zeder Maxims . . .

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"We want men to have convictions, based on sound thinking, and to be willing to stand up for them."

by the addition of capable men under the weak executive.

In any large organization, you are bound to have all kinds and types and grades of people. We must take them pretty much as they come. We must try to fit every man to the job he is best suited for, so that he can make the maximum contribution of which he is capable. Every man has a level, and there is always some niche in that level where he will fit best. You do neither him nor yourself a favor when you try to raise him above his level or move him out of his niche. It is essential, therefore, to be able to recognize the different kinds, in order to dispose them to your and their greatest advantage.

There are several types which occur to me as requiring the greatest attention, management-wise, to get the most out of them.

There is the man who comes into an organization and starts fast, full of enthusiasm and vigor. He gets into the job, but after facing the realities of hard work for a while, he begins to lose his enthusiasm and gradually slows down. In time, he gives up because he is not getting ahead fast enough. That type of man will never make a good supervisor, but he can be kept at peak performance on some subordinate job if his supervisor will take the trouble now and then to pat him on the back, to give him a word of encouragement, and to make him believe that his efforts are being appreciated.

There is another type of man with ability and drive who works his way up to a minor executive position, gets a firm grasp on his job, and then having reached a level which satisfies him, settles back to coast the rest of the way to retirement. There are two things you can do with an individual of that kind. One is to make him dissatified with his level so that he wants to continue battling his way upward. The other is to expose him to competition for his own job. If neither of these works, then you had better get rid of him because there is no place in a live organization for an executive who is coasting.

A third type of individual requires particular attention to make sure he is properly used. He may be highly intelligent and extremely capable technically, but he lacks courage. He is so timid he can't speak his inner convictions in the face of opposition. He will do almost anything to avoid an argument and usually prefers to work alone or in the anonymity of a group. An engineer of this kind can be used to good advantage provided he is placed under a sympathetic and understanding supervisor who will give him the protection he needs while making the most of his talents.

Now while I have been talking about taking people as they come and making the most of them, that does not mean that we should not extend every effort in getting the best that we can find. On the contrary, providing a bank of capable people for the engineering organization is definitely an important responsibility of management.

In our organization, we encourage people to think for themselves—to have ideas and to develop their own lines of reasoning. We want them to have convictions, based on sound thinking, and to be willing to stand up for them. We believe this policy pays off well because it produces high-spirited, independent-thinking men who are enterprising and creative. At times, however, it does complicate the job of engineering management, particularly when you get a group of them together to reach an important engineering decision. Frequently, they all have different ideas and excellent arguments to support them. The big problem of engineering management at this point is to weld their conflicting ideas and diverging opinions into a common conclusion which represents the combined thinking of the group. I don't mean to imply that this is done by brute force, but rather by the painful process of exposing each argument to the criticism of the others, step-by-step cutting away the dead wood and eliminating the erroneous reasoning which doesn't stand

up under close scrutiny, and finally reaching the common ground of mutual agreement.

I don't mean to give the impression that all engineering decisions should be reached only through group thinking. You would never get very much done, if this were the case. At the time Lindbergh flew the Atlantic, someone said to Mr. Kettering, "To think it was done by one man." Mr. Kettering replied, "If it had been in the hands of a committee, it wouldn't have been done at all." The same thing applies to most engineering decisions, so we reserve this method for only those cases where the subject is so complex and the consequences of such far reaching importance that the burden of deciding cannot be left to any one man.

Let me give you an example of an instance of this kind. Recently, we brought out a new V-8 engine for our top Chrysler cars. The development of this engine was started several years ago, but before that program was undertaken, we had to go through the process which I have just described.

We had basically four different groups who were concerned with engine design, and each of them had a different opinion of the kind of engine which we should go to. For two solid years, we held meetings of these four groups every week to reach a decision on the basic design and type of engine which was to be used. There were advocates of horizontal, V-type, and in-line engines. There were advocates of L-heads, F-heads, and overheads. There were those who thought we should have the hemispherical head and others who thought we should have some other kind of head. I remember we must have spent about a dozen meetings on arguments over stroke-bore ratio alone. But the important thing is that at the end of that two years, everyone who had attended these meetings was agreed on one design and type of engine to be released, and we have never had any reason to doubt or change that decision since then. When you consider that the tooling for a new engine commits a company to that basic type for at least 10 years, you can see how important it was to make the right decision.

Incidentally, I might point to this case as an example of the way in which engineering management must concern itself with far more than just engineering problems. It was not enough that this engine should be merely the best engine which we could devise from the standpoint of performance and durability. It was also necessary to consider manufacturing problems. We had to think about costs, and having determined what the costs would be, we had to decide whether the differential with respect to other types was justified by the superiority of the engine being considered. Service had to be kept in mind, and the sales features of the engine were a very definite consideration. Finally, having reached a decision ourselves, we had to be prepared to present our facts to our corporation management in a clear and convincing manner.

In considering these non-technical problems, engineering can frequently find additional ways in which it can be of help to the other divisions of the company. Some years ago, it occurred to us that a great deal of valuable information about our products was lying in our files where it was of no value to anybody. So we established a technical data department whose job it was to compile, interpret, and distribute that information in usable form to other parts of our company which could use it. This proved to be of great value to our sales, advertising, and service departments who had not previously had ready access to such information. Knowledge of the product is essential to a sound merchandising program, and nobody in the corporation should know more about the product than the engineers. It is up to them to supply the ammunition for the sales effort.

Management is feeling its way through a maze of conflicting demands, ideologies, forebodings, and promises. The right kind of management will direct engineering with more and more emphasis upon the individual—upon human hopes and desires—upon the community designed and built from new concepts of the end and aim of corporate enterprise. Part of a design for life can and must come from us—from scientists and engineers who translate dreams into realities.

. . . Zeder Maxims

"Some men start fast in an organization, lose enthusiasm and gradually slow down. . . . Others have ability and drive up to a minor executive job, grasp it firmly, then settle back to coast the rest of the way to retirement. . . . Still others are extremely capable, but lack courage to speak their convictions in the face of opposition. . . . These are the three types which require the greatest attention management-wise to get the best results."

• • •

"In any large organization, you are bound to have all kinds and types of people. . . . We must try to fit every man to the job he is best suited for—so he can make the best contribution of which he is capable."

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BRAKES for Rubber-

WITH the information and experience so far obtained with brake equipment for rubber-tired earthmoving vehicles, the following points constitute some of the basic brake requirements from a design, maintenance, and operational consideration.

Design Requirements

From the design point of view, the following are important:

1. The design must be rugged to withstand the deteriorating effects of exposure to dirt, mud, and water.
2. In addition to physical ruggedness, it should be reasonably invulnerable to damage, either through location in a protected position or in the strength of the individual components.
3. The number of parts must be a minimum.
4. The center clearance on brake components must be large to permit the use of large-diameter hubs or axle housings.
5. The design must be such as to permit ready installation on conventional axle mountings or flanges.
6. In view of the trend toward standardization of wheel equipment, the designer should consider the use of existing wheel designs.
7. It should permit the use of currently available materials.
8. In the interests of low cost, the manufacturing of the components should be possible over machine tooling common to other types of brakes.
9. The design should be capable of being actuated by any of the hydraulic or compressed-air systems commercially available.
10. A continuity of design relationship which will permit the use of the design in various sizes and a complete range of power requirements is desirable.
11. The energizing factor or input/output ratio should be such that the brake effectiveness will not be seriously reduced through the introduction of water, mud, or other foreign material between the friction surfaces.
12. The actuating mechanism should permit the maintenance of large running clearances between the brake lining and brake drum surfaces. Large clearances will permit the passage of ordinary sand or dirt particles without a destructive abrasive action.

Maintenance Requirements

The maintenance requirements of components for earthmoving vehicles are probably the most important of the three categories. This important requirement results from the isolated nature of most of these operations with respect to service bases. In addition to the operating service being strenuous because of its very nature, the desire in many contracts to keep in continuous operation tends to aggravate the maintenance problem. The service facilities available on many operations are improvised or of the road service type. The introduction of long life in the basic design is important in reducing maintenance but the service periods are difficult to regulate to eliminate the need for replacements at inopportune times when the vehicle is most needed. The only known method for handling this condition is to ensure in the design of the components, and especially brakes, an ease of maintenance that will give minimum out-of-service time. The maintenance considerations are as follows:

1. Clearance adjustment for lining wear should be simple and accurate.
2. The brakes should be capable of being serviced in the field. This has particular reference to relining.
3. The replacement of wearable items should require a minimum out-of-service time for the vehicle. Long service life is important but can be nullified in its value if tie-ups for service are prolonged.
4. Points of lubrication should be few and require infrequent attention. Journals should be sealed or prepacked to require minimum periodic attention. Those lubricating points which require regular service should be readily accessible.
5. The servicing of the brakes should be possible without removing the wheel hubs and, if possible, without removing the wheels.
6. Service parts should be readily available through a possible relationship of common parts with other types of brakes which may be more widely used.
7. The *unit* replacement of component assemblies should be evaluated with respect to minimizing down time and ensuring a good quality of service.

Operational Requirements

The operational requirements for brakes are not as numerous as the design requirements but are equally as important. Among those to be considered are:

1. The brakes must be capable of repeatedly delivering the high torque required for off-road type of service involving steep grades and generally rugged terrain.
2. They should be sensitive in control to permit their use for steering purposes when desired.
3. The operation of the vehicle over either hard-surfaced highways or prepared roads at increasingly higher speeds imposes a heat dissipating requirement in the brake design that is equally as important as the torque ability of the brake.

Tired Earthmovers

EXCERPTS FROM PAPER BY

R. K. Super, Brake Division, Timken-Detroit Axle Co.

• Paper, "Heavy-Duty Brake Requirements of Rubber-Tired Earthmoving Vehicles," was presented at the Earthmoving Industry Conference of the SAE Central Illinois Section, Peoria, Ill., April 10, 1951.

4. The stability of the brakes and their ability to be operated by remote control throughout a combination of vehicles to maintain desired control of the train is highly desirable and important operational requirement.

The brake design, operational, and maintenance requirements for earthmoving equipment that have been briefly outlined indicate a broader understanding of the problem at the present time than prevailed possibly 10 years ago. There are a number of improvements or changes which are recognized as necessary or desirable in the current designs to meet the above requirements better. Some of these relate to materials and others pertain to the mechanism or complete brake. Among the most necessary improvements or changes are:

1. Larger brakes to handle the heavier loads at increased speeds. A 24-in. or 26-in. diameter brake should be considered for use inside 28-in. base tire rims.

2. New brake drum materials and designs that will provide greater strength and heat dissipating capacity.

3. New brake linings providing longer life and greater stability of friction under the complex operating conditions involving high temperatures and also exposure to water and dirt.

4. Larger power units and operating levers of higher capacity. Immediate future requirements indicate the need for a 75 sq in. power unit for air systems and an operating lever having a 45,000 lb-in. torque capacity.

5. Better sealing between the dust shields and brake drum with possibly the introduction of a labyrinth type of seal. This type of seal could be added to brakes already in service as well as current production designs. Its purpose would be to minimize the entrance of thick mud and dirt into the brake cavity without adding complications to the servicing of the brake. A labyrinth type of seal would meet present requirements without the complications of design and maintenance necessary in the introduction of fully enclosed brakes or rubbing seal brakes. Both of the latter types of enclosures are more expensive and require more maintenance attention than the labyrinth seal design.

6. An improved method of fastening the brake lining to the brake shoes. At the present time the blocks are held to the shoes by either bolts or rivets.

Both of these types of fastenings have been used for many years for attaching heavy blocks to brake shoes, with the rivets having the advantage of providing more points of attachment and a tighter fastening, due to the rivets expanding and filling the holes. The exponents of bolts claimed a time saving in making field relines but have ceased to justify this claim with the introduction of explosive rivets. Neither rivets nor bolts offer the high holding strength of bonding cements. A continuous friction surface having no cavities for dirt accumulation is also an important feature obtainable by bonding linings. The cement further prevents the entrance of water between the shoe and lining surface, with resultant shearing of the fastening. The acceptance of unit replacement of shoe and lining assemblies for field servicing makes bonded lining a valuable consideration.

7. The pins and journals require better lubrication either through the use of oil-impregnated materials or the introduction of carefully sealed joints that permit prepacking. Overlubrication of brake parts is objectionable and serious. Periodic lubrication is also an unwanted service detail.

Future Requirements

That which has been outlined seems to cover the the status of brakes for earthmoving equipment in the past and, to a certain extent, the designs and changes to meet present requirements. The progressive nature of this industry warrants consideration of future requirements. This phase of the

THE earthmoving equipment industry has made tremendous progress in design in recent years, the author says, and there is every indication that more changes are to be expected.

Brakes for this classification of rubber-tired vehicles are very important, he points out, and should receive the same careful engineering study and development given the other components if the increasing brake requirements are to be successfully handled.

As an aid to further development of these brakes, the author has set up, in the accompanying article, the basic requirements of the brakes for this type of equipment.

brake requirement problem is somewhat speculative but the steady increase in vehicle capacities with subsequent increase in weights may require an approach paralleling that which developed in the logging industry.

First, the wheel brakes must be made as large as the space limitations will permit. This will provide maximum torque ability and energy capacity.

Second, the brakes must be used on all of the wheels on the vehicle.

Third, supplementary brakes should be seriously considered as a necessary part of the braking system. This classification of brakes is typified commercially by the Parkersburg Hydrotarder and the Warner eddy-current brake. These brakes in conventional installations are mounted in the drive line of the propelling vehicle and act through the driving wheels to retard the motion of the vehicle. They provide no holding or parking feature. The Hydrotarder uses water as the braking medium and combines the circulating system of the brake with the cooling system of the vehicle engine. The basic components of the braking unit are a stator supported in the vehicle frame on cross-members and a rotor which is attached to the through shaft, which in turn is a part of the vehicle drive line. Braking is accomplished by admitting water to the stator cavity in a quantity to give the desired braking effect. The brake is released by pumping the water from the stator cavity. The unit is sealed against dirt and water contamination. This braking device is widely used on combination vehicles grossing 150,000 to 200,000 lb.

The eddy-current brake is an electrical version of a brake having a similar function. The excitation of an electric field provides a variable braking effect with a minimum delay. The energy of braking is dissipated to the surrounding air through a sirroco fan effect. The mounting in the vehicle drive line is similar to that of the Hydrotarder. The performance of the eddy-current brake in off-road type of service is not as well defined as the Hydrotarder, but it should be considered in this appraisal.

Other locations for mounting these units have been used but the preferable one is on the propelling vehicle.

Space limitations have been one of the deterrents to a wider use of these brakes but some compromise has, in general, been possible to permit their installation.

A third type of supplementary braking that may enter this field is that of regenerative braking, typified at the present time by that used on trolley buses. A consideration of this system depends largely on developments in vehicle propelling mechanism.

Supplementary braking devices for earthmoving equipment are not an innovation but offer an important contribution to handling increasing brake requirements as vehicle speeds and loads move to higher figures.

Brake Calculations

The power and capacity ratings for applications of brake equipment to earthmoving vehicles has followed the fundamental formulas and methods that have been found practical for the analysis of brakes for heavy-duty highway vehicles.

The brake torque requirements found most desirable in recent designs have been based on a tire-ground tractive factor of 0.75. This factor is obtainable at the full operating pressure of the power system. The various brake power formulas for each brake design which will indicate the relationship between the power input requirements of the brake to give the brake torque output equivalent of this tractive factor are available from each brake manufacturer. A typical one used for cam-operated brakes is as follows:

$$\text{Brake torque requirement} = W \times 0.75 \times R_T$$

$$\text{Brake torque} = P \frac{AL}{r_c} \times f \times D$$

where:

W = Weight on wheel at ground, lb
R_T = Rolling radius of the tire, in.
P = Maximum operating pressure of the power system, lb-in.
A = Area of power cylinder, sq in.
L = Operating lever length, in.
f = Coefficient of friction of the lining
D = Diameter of the brake drum, in.
r_c = Cam base circle radius, in.

The equating of the brake-torque factors to the brake-torque requirement will permit the solution of the equation for any of the factors. The one most generally desired is the AL factor for selection of the power cylinder size and length of actuating lever.

The brake torque analysis has no relation to the life of the brake or the ability of the brake to dissipate the heat energy equivalent of braking. For consideration of brake capacity, it is generally accepted that the most important factors are the width and diameter of the brake. The work imposed on the brake is a function of the weight on the wheel and the rolling radius of the tire. The capacity of the brake to handle this load is a function of the diameter and width of the brake and the acting through the advantage of the drum radius. The ratio of the ability of the brake to the work imposed is the brake capacity factor. Expressed as a formula, it appears as:

$$\text{BCF} = \frac{D^2 \times W}{6 \times L \times R_T}$$

where:

D = Diameter of the drum, in.
W = Width of the drum, in.
L = Weight on the wheel, 1000 lb
R_T = Rolling radius of the tire, in.

The BCF for rubber-tired earthmoving vehicles is a constant of the value of (1.2 to 1.4). The introduction of this capacity constant in the formula will permit the establishing of brake diameters and widths for various loads and tire sizes.

The torque and capacity methods for calculations of brakes for these large vehicles is supported by similar formulation for heavy-duty highway vehicles and it is believed that only by a broad and continued use of the two methods can the constants be reestablished to compensate for changing reqnirements for both brake power and capacity.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Engines and Fuels

1. Average Progress in Cars and Fuels
2. Past, Present, and Future of One Car
3. Problems Involved In Octane Utilization

BASED ON PAPER BY

C. L. McCuen, General Manager, GM Research Laboratories Division

• Paper, "Economic Relationship of Engine-Fuel Research," was presented before the Canadian Section of the SAE, Toronto, Can., May 18, 1951. Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

PROBABLY no single product in history has been given so much consideration by organized research laboratories and individual inventors as the automobile.

During the half century since its invention, tremendous engineering effort has been expended to give it the performance, economy, durability, and reasonable cost demanded by the driving public.

Thousands of devices that have shown promise have been studied in the research laboratories and engineering departments of the industry. But even the developments that were successful in the laboratory still had to gain public acceptance by meeting the varied conditions of everyday use in service.

This has been particularly true of the automobile powerplant. Engines of many types and variations were explored and found deficient in some respect —and this constant search for a better engine is still being carried on today.

Coupled with these improvements in the engine has been the development of better fuels. In particular, its antiknock quality has been constantly raised through the years to keep pace with the increasing octane demands of engines.

Presented on the next two pages is a series of graphs that show trends in the automobile industry from 1930–1950, in terms of size, performance, and fuel consumption characteristics for 29 car models representing 15 manufacturers.

Included also is a curve showing what has happened to octane quality during the period 1912–1950.

This is followed by an example illustrating the effect of improvements on one particular make of car.

Three Cadillacs—built in 1915, 1935, and 1951—were tested under comparable conditions. The future was represented by a model designated as 19XX—actually a 1951 Cadillac with the standard engine replaced by an experimental one of 12/1 compression ratio. This car demonstrates possible gains that can be made with the present high-compression-engine program.

The production of cars with engines of 12/1 compression ratio would have many benefits: an additional 30% increase in efficiency, the engine could be built smaller and lighter, thus using less material. Since less heat would be wasted in the cooling water, smaller radiators would be needed, using less copper. The smaller, lighter engines would also open up new possibilities for chassis and body engineers.

In general, of course, an increase in compression ratio, engine design remaining the same, is accompanied by a need for fuel of higher octane number.

Many design changes can be made in an engine, however, that allow it to operate on a fuel of lower octane rating—increasing the mechanical octane numbers, as it is called.

Thus, the key to these improvements becomes that of greater octane utilization. On the final page of this article is a series of illustrations that indicate some of the problems involved in utilizing fuel octane numbers.

It is with this sort of information that the industry is making progress in its never-ending search for better fuels and engines—engines that better utilize available fuel.

How far we go in the matter of increasing compression ratio thus seems to depend on the progress that can be made with mechanical octane numbers and the extent to which technological progress in the petroleum industry permits the general distribution of fuels of higher octane number.

In the final analysis, however, normal competitive forces operating in a free economy will determine how high it is commercially possible to go in increasing the compression ratio of engines and the octane numbers of fuels. These forces will also determine how rapidly we can progress in obtaining higher engine efficiencies in production engines.

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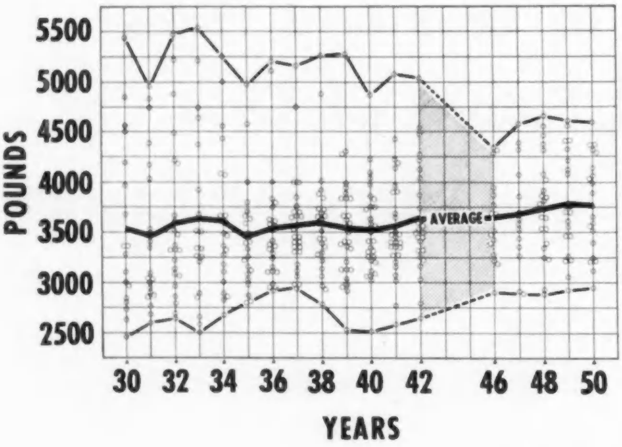
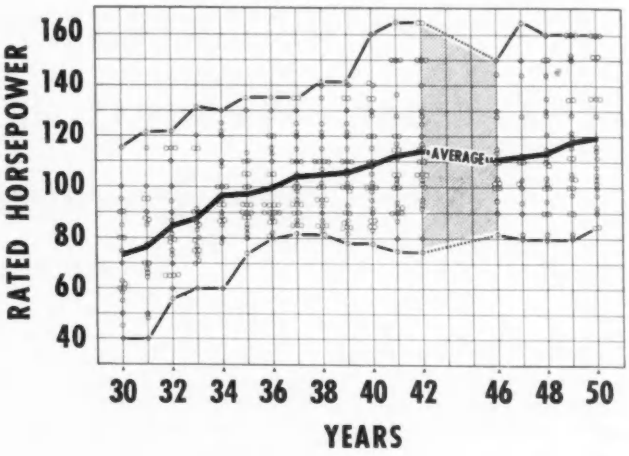
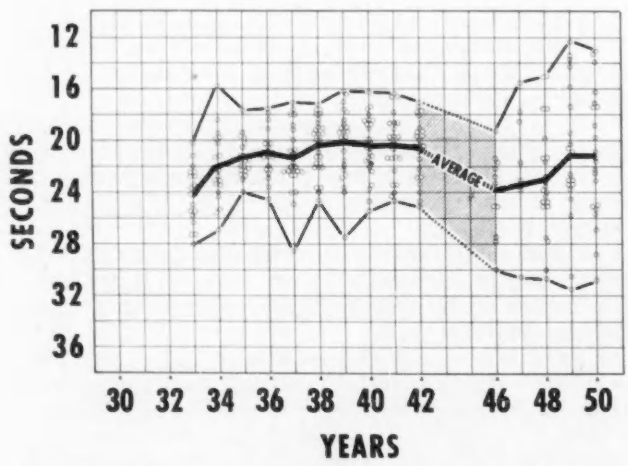
1. Average Progress



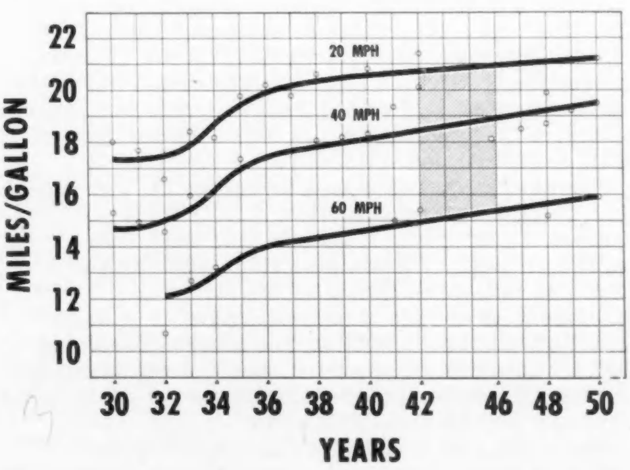
Average curb weight of cars increased from 3500 lb to to 3750 lb during the period under study. Note, however, that very large cars were reduced in weight by almost 1000 lb, while the small cars were increased by almost 500 lb. There is much less spread between the heaviest and the lightest cars in 1950 than there was in 1930. These data are important in interpreting the performance data shown in the other curves in this group.



The above curves show that rated horsepower went up rapidly, the average engine increasing from less than 75 hp in 1930 to almost 120 hp in 1950 models. This was necessary to obtain the better performance demanded by the customers. As in all of the trend data, the spread between the lowest and highest values in any year is very great. For instance, in 1950 the lowest was 85 hp and the highest was 160.

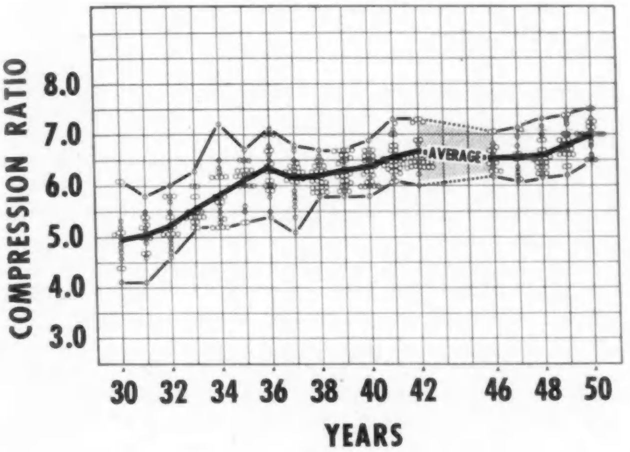


These curves of acceleration from 10 mph to 60 mph indicate increased performance. Since resumption of production in 1946, however, some unusual factors have affected the trend. Several low-performance cars are plotted. These sacrifice performance to gain economy. Note, however, that the highest-performance cars represent those with the most modern high-compression engines, and thus are among the most economical.

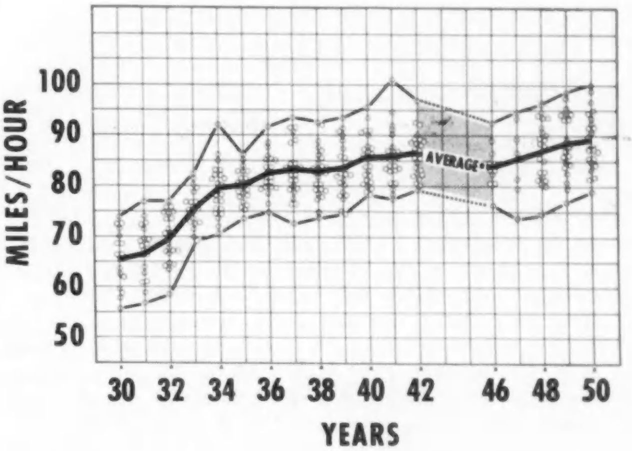


These average curves of level-road constant-speed economy show that there was a constant upward trend in miles per gallon. For instance, at a cruising speed of 40 mph, the average increased from about 15 mpg to almost 20 mpg. This is more than a 30% increase in economy, even though our automobiles have become larger and faster. A large increase is noted at all speeds from the lowest to the highest.

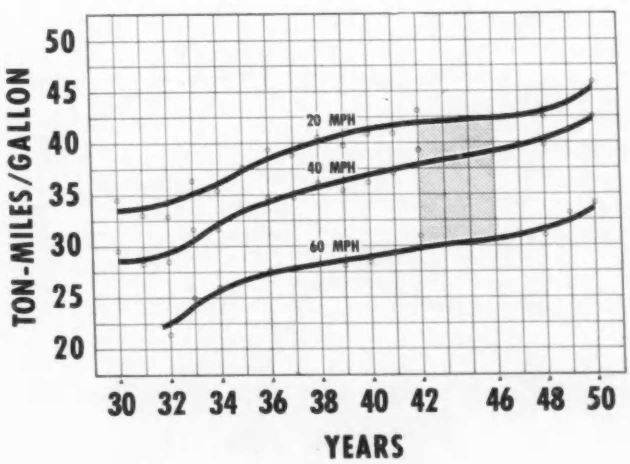
in Cars and Fuels



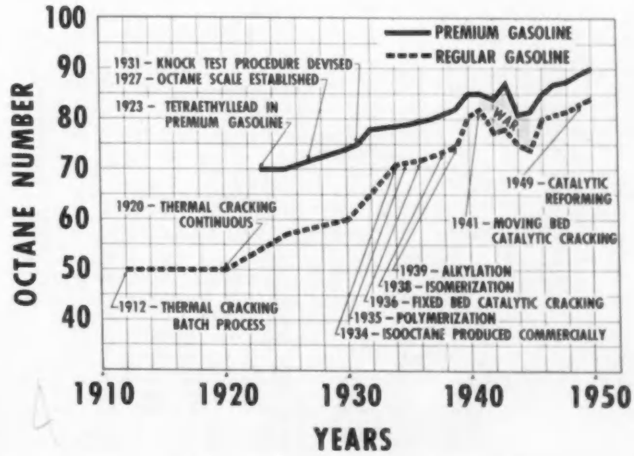
At least part of this increased power can be accounted for by the increased compression ratio. There has been a net change of two ratios on the average over this period. Most newer engines have a compression ratio of 7.5/1 and even the lowest in 1950 was 6.5/1. These increases were made possible because of the emphasis placed on increased engine efficiency in all research and development programs, plus a better fuel.



The above curves show that the top speed of the average automobile increased from 66 to almost 90 mph. The increase is a natural result of developments to give better acceleration and hill climb at all speeds. This curve is shown because, although increased top speed is not the aim of present automotive development, it is a value that results from the increased performance demanded by modern drivers.



The above graph based on ton-miles per gallon is a more fundamental analysis from the standpoint of engine and transmission development. At 40 mph, ton-miles per gallon increased from 29 to 42.5. This represents a gain of 46% in the ability to move a ton a mile with a given quantity of fuel, or about a 2% increase per year. The values illustrate the large gains made during the period covered.



Improvements in antiknock seem to have begun about 1920 with the large-scale commercialization of thermal cracking. Then in 1923 the introduction of tel gave another significant jump to octane numbers. In the late 1930's several developments made further improvements possible. In 1949 catalytic reforming appeared. It promises to increase the octane number still further.

Continued on following pages →

2. Past, Present, and Future of One Car

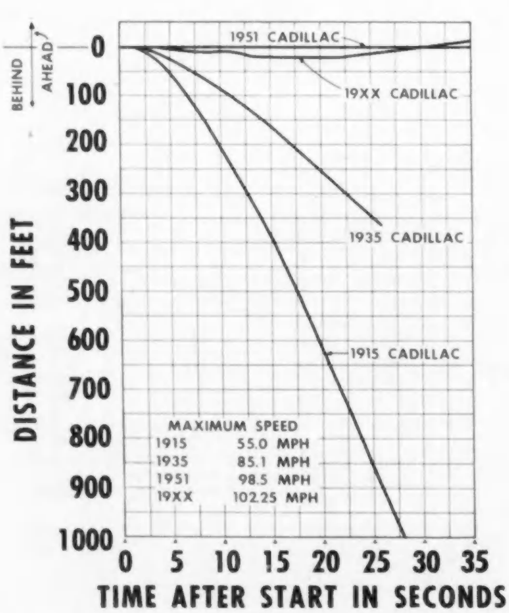
FOUR Cadillacs—representing past, present, and future cars—were tested at the GM Phoenix Laboratory under comparable conditions. They were run under our present standard test procedures using modern instrumentation, so that the results would be directly comparative. Special fuels were provided so that performance and economy data would reflect the results to be expected in the year each car was produced.

It is believed that this is the first time anyone has run a series of tests on old and new cars using modern instrumentation and test procedures.

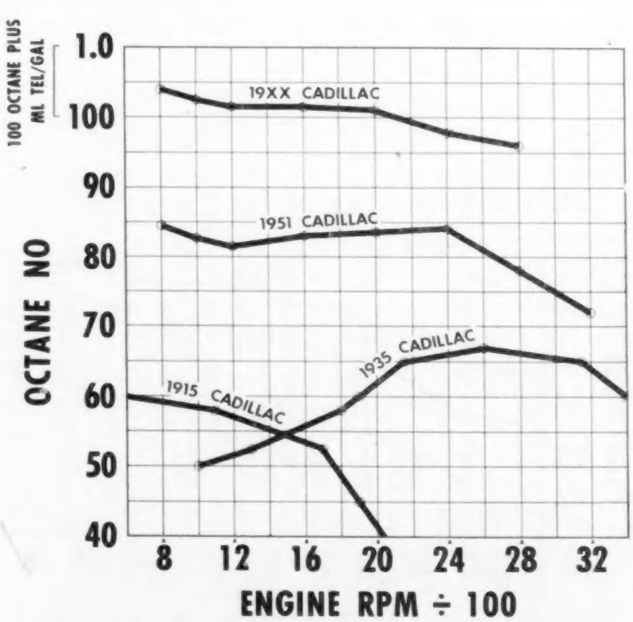
The four Cadillacs represent various stages of engineering development in the automobile industry. Table 1 shows comparative data on these cars. When the 1915 Cadillac was announced, in the year the Lusitania was sunk and transcontinental telephone service was inaugurated, it introduced the first American V-8 engine. The 1935 Cadillac was produced in the year that Italy invaded Ethiopia. The 1951 car is a standard Cadillac sedan representing present production standards. The 19XX car is a 1951 Cadillac sedan with an experimental engine of 12/1 compression ratio. The early cars represent spans of 16 and 20 years, which cover a sufficient period to obtain a long-range view of the progress made by this manufacturer. The experimental car serves to demonstrate the possible future gains that can be made in our present high-compression-engine program.

The 19XX car not only has the experimental 12/1 engine, but it also has an improved hydra-matic transmission developed by the Detroit Transmission Division.

The displacement chosen for the 12/1 engine is such as to give about the same horsepower characteristics, and hence the same road performance, as is obtained on the 1951 Cadillac. Thus, in the 19XX car, the experimental high-compression engine demonstrates clearly the fuel economies that



The 1951 model was used as the standard, so it is represented by the zero line. The curves show the distances the other cars were ahead of or behind the 1951 car at various times after the start. It can be seen that the 1915 and 1935 cars fell back of the 1951 car very rapidly. The 1951 and 19XX cars have practically the same performance from a standing start out to the limit of the test. This was the aim in fitting the 12/1 engine in the Cadillac chassis.



The requirement of the 12/1 car was equal to 100 octane plus 0.4 ml tel, estimated at 103 octane number. The others were designed to operate on fuels current at the time of their manufacture. The curves show the results of road octane requirement tests in terms of iso-octane and normal heptane. Although the 1951 car had a requirement of only 85 when the combustion chamber was clean, 90-92-octane fuel may be required with the formation of deposits in service.

Table 1—Cadillac Test Car Data

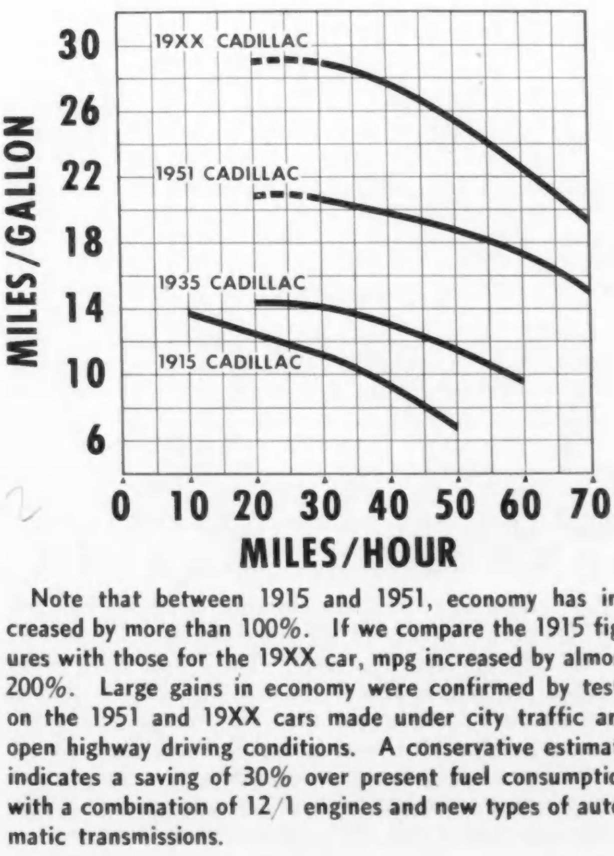
	1915	1935	1951	19XX
BORE	3-1/8	3-3/8	3-13/16	3-3/4
STROKE	5-1/8	4-15/16	3-5/8	3-1/4
DISPLACEMENT	314	353	331	287
COMPRESSION RATIO	4.25	6.25	7.50	12
BRAKE SPECIFIC FUEL	–	0.63	0.55	0.46
MAX BRAKE TORQUE	152	234	268	266
MAX BMEP	73	100	122	140
MAX BHP	77 @ 2600	*108 @ 3000	*133 @ 3600	*148 @ 4000
HP/CU IN	0.245	0.306	0.402	0.522
WHEELBASE	122	128	126	126
CURB WEIGHT	4140	5050	4440	4440
ENG RPM/MPH	46.5	51.4	40.2	32.9
AXLE RATIO	5.07	4.6	3.36	2.75

*AS INSTALLED HORSEPOWER G M TEST CODE CORRECTIONS AND PROCEDURES

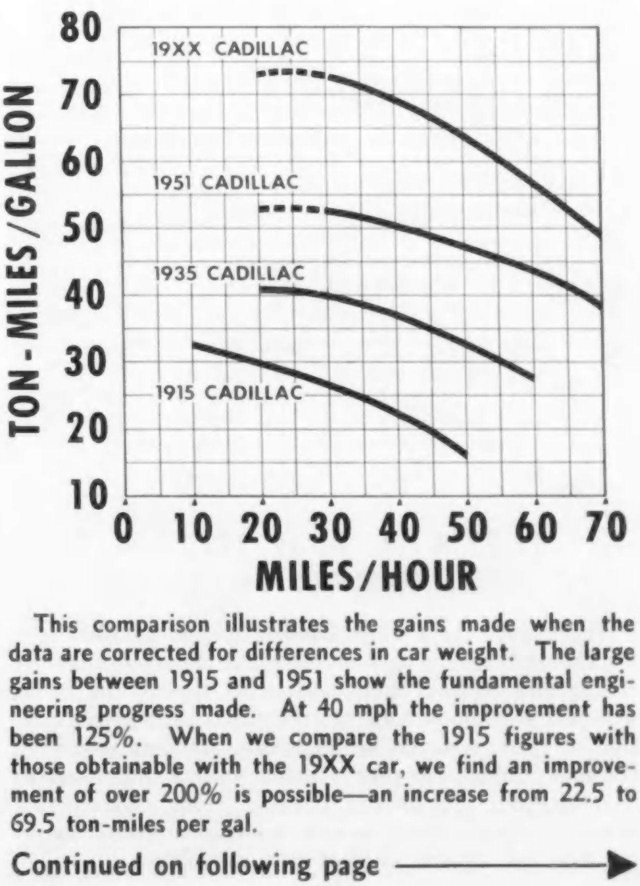
Cadillac test cars lined up according to year. Left to right: 19XX, 1951, 1935, and 1915 models

are possible with this powerplant-transmission combination.

While it seems that present performance characteristics are adequate from the standpoint of existing traffic conditions and available roads, the possibilities of modifying this design to provide greatly increased horsepower with substantial savings in fuel economy over existing engines are virtually unlimited. Of course, a 12/1 engine with the same displacement as the 1951 Cadillac is capable of developing greatly increased horsepower in comparison with the engine used in these tests. In fact, it seems certain that any power demanded by the customer can be provided.



Note that between 1915 and 1951, economy has increased by more than 100%. If we compare the 1915 figures with those for the 19XX car, mpg increased by almost 200%. Large gains in economy were confirmed by tests on the 1951 and 19XX cars made under city traffic and open highway driving conditions. A conservative estimate indicates a saving of 30% over present fuel consumption with a combination of 12/1 engines and new types of automatic transmissions.



This comparison illustrates the gains made when the data are corrected for differences in car weight. The large gains between 1915 and 1951 show the fundamental engineering progress made. At 40 mph the improvement has been 125%. When we compare the 1915 figures with those obtainable with the 19XX car, we find an improvement of over 200% is possible—an increase from 22.5 to 69.5 ton-miles per gal.

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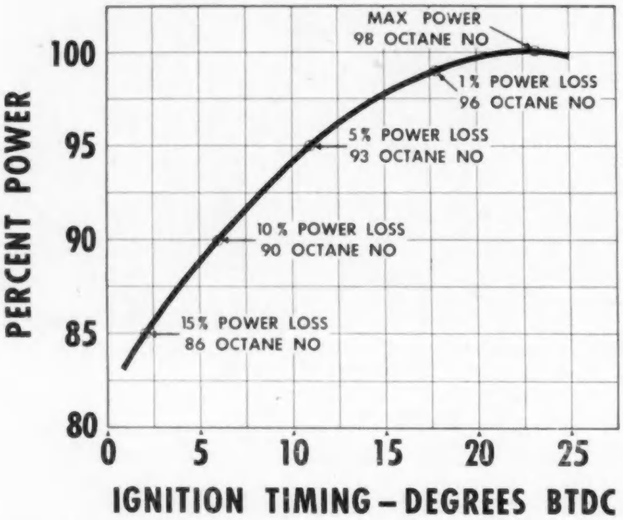
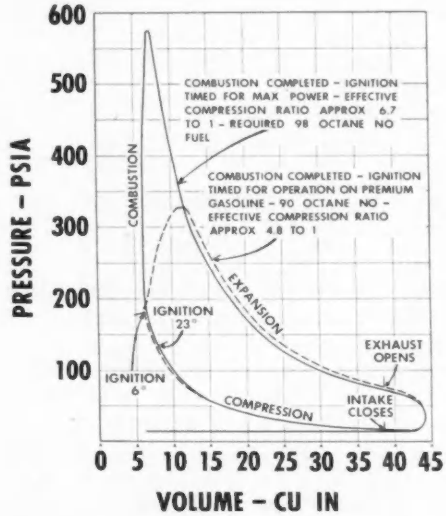
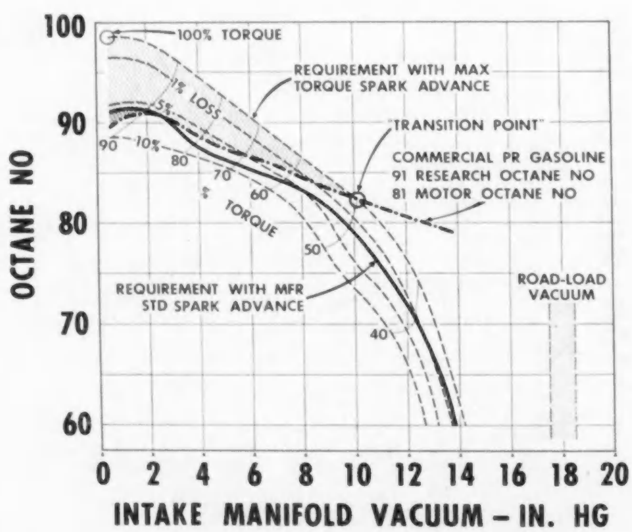
3. Problems Involved in Octane Utilization



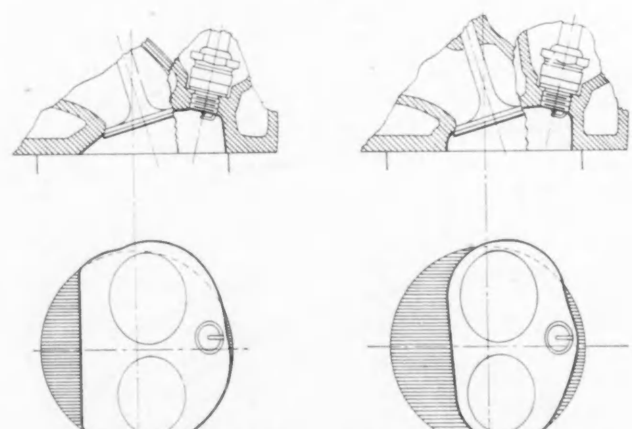
This curve of per cent of maximum power at various spark timings for a single-cylinder Research engine at full throttle, 1000 rpm, 7.25 compression ratio, illustrates the principles involved in using spark timing to obtain mechanical octane numbers. With spark retarded 6 deg, which gives a 10% power loss, the octane requirement is 90, as compared with 98 at maximum-power spark timing. Thus, if the designer would take a 10% power loss at this speed, he would gain 8 mechanical octane numbers.



This shows what happens in the combustion chamber with a 6-deg spark retard. With ignition at 23 deg BTDC for maximum power, the explosion pressures reach 575 psi and 98-octane fuel is required. At 6-deg retard, the pressures reach only 325 psi, so the requirement drops to 90. This sort of compromise is practical because the automobile engine is operated at full throttle only a small part of the time. At part throttle it is then possible to advance timing to get full benefit from higher compression ratio.



This curve, for a 1950 Cadillac engine at 1000 rpm, shows spark setting is such that the engine utilizes the fuel octane number from wide-open throttle to 10 in. manifold pressure or half throttle. Thus, with proper control of spark advance for maximum-economy operation, the fuel antiknock quality is needed over a wide range of openings—not just at full throttle. This utilization of octanes is accomplished by such means as automatic spark-advance and variable air/fuel ratio carburetors.



1950—7.25 TO 1 C.R.
15.8% PISTON COVERAGE

1951—8 TO 1 C.R.
30% PISTON COVERAGE

Comparison of combustion chambers used in 1950 and 1951 Oldsmobiles (actually a 7.5 compression ratio is used on the 1951 production engine). The difference in what is called piston coverage of the two chambers is shown. Extensive road tests proved that the average octane requirement of the 1951 head is slightly lower than that of the 1950 head—a gain of three-quarters of a compression ratio, which is equivalent to about 8 octane numbers. This higher ratio gave a gain of 2 mpg in fuel consumption.

Additives Eliminate Auto Carburetor Icing

BASED ON PAPER BY

J. F. Kunc, Jr., J. P. Haworth, and J. E. Hickok

Esso Laboratories, Research Division, Standard Oil Development Co.

• Paper, "A New Look at Motor Gasoline Quality—Carburetor Icing Tendency," was presented at the SAE Annual Meeting, Detroit, Jan. 9, 1951.

FORMATION of ice in the carburetor has long been recognized as the cause of stalls during cool and wet weather, when the car owner attempts to idle his engine before it is thoroughly warmed up.

In recent years, however, the number of complaints that dealers have been receiving on this score has jumped appreciably.

A number of factors contribute to this increase in severity, all of which have made the motorist increasingly aware of poor idling performance in his car:

1. Most cars manufactured since the end of the war are not equipped with a manual throttle control, so that a great number of drivers suddenly find themselves unable to increase the idle speed conveniently during the warmup period in an attempt to prevent stalling.

2. The idle speed of cars with automatic transmissions is rather critical during warmup and must not be too high, to avoid creeping. The car so equipped idles at a somewhat slower speed and is thus more critical with respect to stalling.

3. When the engine of the car with automatic transmission stalls, the driver frequently is not aware of it until he is ready to accelerate, when he finds he must shift gear to neutral, restart the engine, and then shift back into gear. Thus, he becomes very conscious of each stall.

The continuing effort of the automotive industry to build a car that is more and more automatic has served, therefore, to focus the attention of the motorist on the ability of his car to idle satisfactorily.

Conditions for Icing

Fig. 1 is based on observations—through a glass section—of the formation of ice in an automotive carburetor in actual operation. It can be seen that the critical factor is ice building up on the throttle plate.

These studies showed that light-load operation produces maximum refrigeration of the carburetor parts. Ice begin to form as soon as these parts are chilled below about 30 F, so that when the throttle is closed to the idle position the ice already on the throttle plate and adjacent walls—plus any that quickly forms to close the narrow air openings further—will serve to restrict the normal flow of air to the engine, with subsequent repeated engine stalling.

The engine can easily be restarted, for the ice melts almost immediately, however, (1) because of the residual heat from the exhaust manifold and (2) because of the normal starting procedure in-

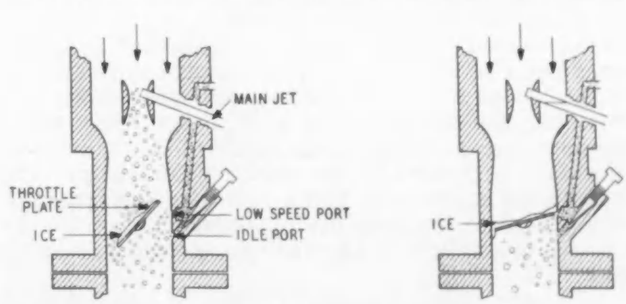


Fig. 1—Automotive carburetor ice formation—left: light load, maximum refrigeration, vaporization of fuel causes chilling of throttle plate and surrounding parts; right: idle, maximum ice formation, closing of throttle, following light-load operation, permits ice to bridge air openings and thus to restrict flow of air to engine, causing stall

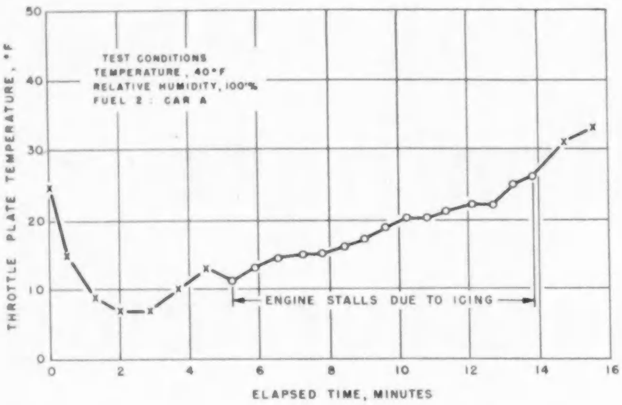


Fig. 2—Change in carburetor throttle-plate temperature with time

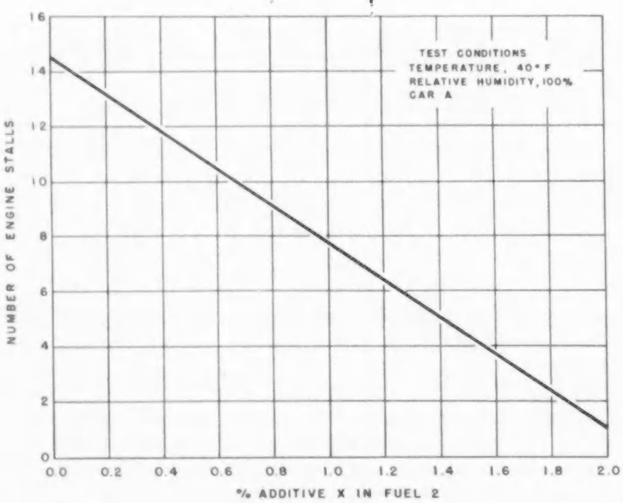


Fig. 3—Effect of concentration of additive X on carburetor ice formation

volves additional opening of the throttle. Stalling is normally encountered during the first four or five minutes of operation, following a cold start, but it may last as long as 15 min under severe conditions.

The degree of refrigeration possible in the carburetor due to the vaporization of gasoline is shown in Fig. 2, where the change in throttle-plate temperature during the warmup period of one make of car operating under alternate light-load and idle conditions on a commercial winter grade of gasoline is plotted as a function of elapsed time. With air entering the carburetor at 40 F, the throttle-plate temperature reached a minimum of 7F, and then gradually increased as the engine warmed up. Engine stalls at idle due to ice formation began at a throttle-plate temperature of about 10 F and continued for 9 min to a throttle-plate temperature of 25 F.

Ways of Reducing Icing

Three ways of reducing the severity of ice formation were studied, as follows:

1. Reducing the volatility of the gasoline being used.
2. Increasing the flow of heat to the carburetor.
3. Use of additives in the gasoline.

Only the last one, namely, the use of additives, can be considered to reduce the ice formation without creating other problems. Even here, care and judgment must be exercised in the selection of the compound and the concentration used, since some compounds suitable as additive agents may be entirely unsuitable in other respects, particularly as to the formation of fuel or induction system deposits.

Reducing the volatility of the gasoline resulted in a fuel that gave a warmup time that was so long that the fuel would be unacceptable to the motorist during any any season of the year. The fuel would also be likely to have poor cold-engine acceleration, economy, and crankcase dilution.

Increasing the flow of heat to the carburetor would probably also increase susceptibility to vapor lock, so that some sort of compromise would have to be made.

Laboratory tests conducted with a number of materials showed, however, that when they are added to the gasoline in low concentrations, they will reduce markedly the tendency of the gasoline to form carburetor ice.

Data on three such additives are presented in Table 1. The additives shown are not all equally effective, but each is capable of preventing the formation of carburetor ice when used in the proper concentration.

The effect on icing severity of different concentrations of additive X, for example, in the winter grade of gasoline at 40 F and 100% relative humidity is shown in Fig. 3.

These data indicate that somewhat more than 2% of additive X would be required to eliminate ice formation under the conditions of the test. On the other hand, it will be seen that, from the data plotted in Fig. 4, by reducing the range of atmospheric conditions in which icing might occur, the addition of 2% of additive X has the effect of practically eliminating the incidence of icing.

This reduction in range of conditions causing icing results in a corresponding decrease in the per cent of hours during a given season of the year in which icing might occur with various concentrations of this material in winter premium-grade gasoline.

Illustrative data for December, January, and February, in a typical city on the Eastern seaboard, are shown in Fig. 5. These data show that the incidence of icing would be reduced from 34% of the monthly hours on the base gasoline to 10% with

Table 1—Effect of Fuel Additives on Icing Severity (40 F and 100% relative humidity, car A)

	Number of Engine Stalls
Fuel 2	14
Fuel 2 plus 1% Additive X	8
Fuel 2 plus 2% Additive X	1
Fuel 2 plus 0.05% Additive Y	7
Fuel 2 plus 0.50% Additive Y	1
Fuel 2 plus 0.1% Additive Z	4
Fuel 2 plus 0.5% Additive Z	0

Table 2—Influence of Additive X on Stalling in Customer Car Tests

Test Period: December, 1949, through April, 1950		
Total Number of Cars		28
Total Number of Makes of Cars		11
Cars with Automatic Transmissions, Fluid Drive, or Overdrive, %		32
	Approximate Per Cent Evaporated (at 212 F) of Gasoline Used	
	46	55
Number of Cars	9	19
Without Additive X (per Car, Average)[a]:		
Number of Trips When Stalling Would Be Expected	26	73
Number of Stalls per Trip	4	7
Total Number of Stalls during Test Period	104	511
With 2% Additive X (per Car, Average):		
Number of Trips When Stalling Was Experienced	2	10
Number of Stalls per Trip	0.5	1
Total Number of Stalls during Test Period	1	10
Reduction in Icing Severity, %	99	98

[a] Estimated from past performance and base checks without additive X conducted during test period.

1% of the additive, and to 2% of the hours when 2% of the additive is used.

To determine whether the reduction in carburetor icing provided by additive X in laboratory tests was sufficient to eliminate customer annoyance caused by carburetor icing, 28 customer-owned cars, representing 11 makes, were operated on 2% additive X in the gasoline normally used, from December, 1949, through April, 1950. Atmospheric conditions were very often in the icing range during this period. The cars participating in this test had a past history of frequent engine stalls during cool, wet weather and, in general, represented a reasonable cross-section of the makes that are most susceptible to carburetor ice formation. About 32% of the cars had automatic transmissions, fluid drives, or overdrive features, which would tend to permit easier stalling from ice formation, compared to an estimated 12% of the total cars on the road that have features of this type. The kind of choke apparently had little effect on icing severity, since the cars in the test were equally divided between manual and automatic chokes, and no differences were noted.

From base checks made on the cars from time to time during the test, using gasoline without additive X, and from past car performance, it was possible to compare directly the performance with and without the additive in the gasoline. This performance has been expressed as the total number of stalls that were experienced by the average car during the entire test period, when operating on the base gasoline containing 2% additive X, as compared to the estimated number of stalls that would have been experienced when operating on the base gasoline alone. The results, shown in Table 2, indicate that the addition of the additive to the gasoline reduced stalling sufficiently practically to eliminate the problem of ice formation as far as the average consumer was concerned. The few stalls that were obtained with the fuel containing additive occurred during heavy fog.

Similar results were also obtained with the proper concentration of the other additives.

It appears that the use of the additives tested, in the proper concentrations, will not introduce additional performance problems. In particular, 2% of additive X was determined not only to cause no increase in fuel and induction system deposits, but to tend to reduce existing deposits to a small degree. In addition, this material was found to have no adverse effects on gaskets, floats, fuel pump diaphragms, or other parts of the fuel system. Certain of the additives, which showed promise for reducing carburetor icing severity, are soluble in water to some degree, so that their use in gasoline tends to prevent freezing of any water that may be present in the fuel system, thus avoiding fuel line freezing, which is quite a common occurrence in extremely cold weather.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

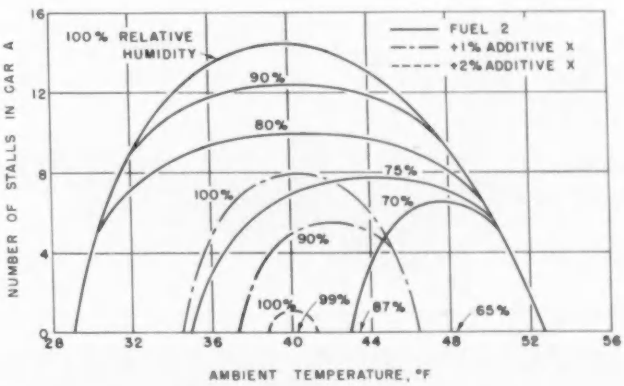


Fig. 4—Effect of temperature and humidity on icing severity

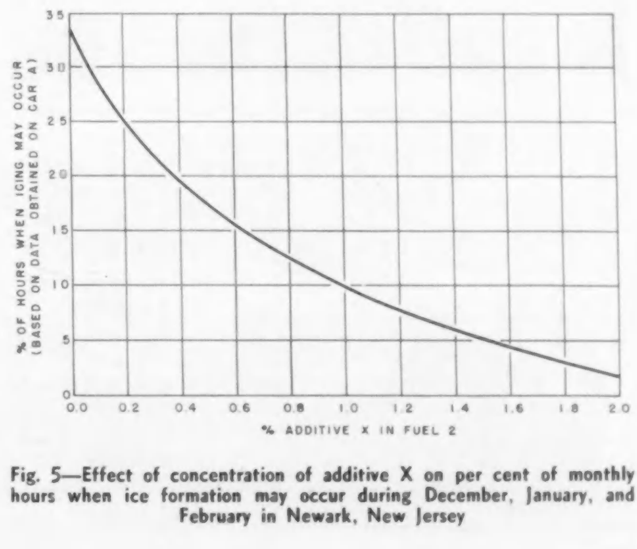


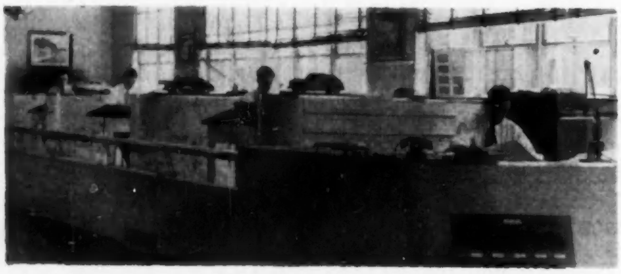
Fig. 5—Effect of concentration of additive X on per cent of monthly hours when ice formation may occur during December, January, and February in Newark, New Jersey

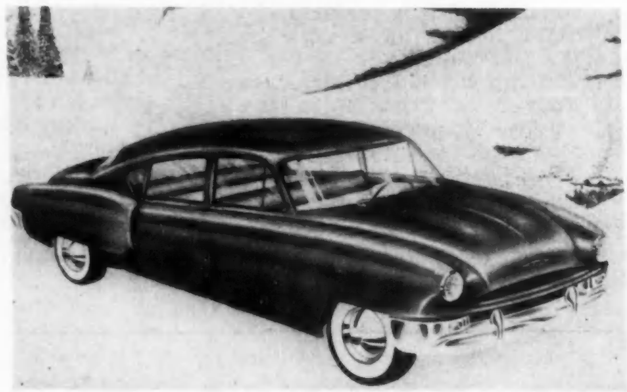
A NEW BODY IS BORN

BASED ON PAPER BY

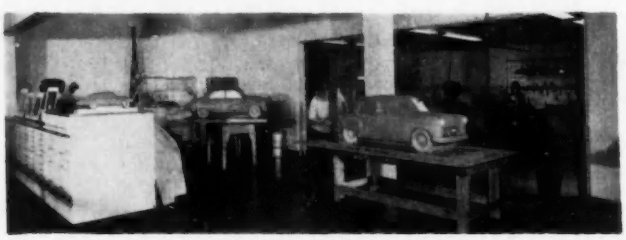
A. R. Lindsay, Chief Automotive Engineer, The Budd Co.

• Paper, "Passenger Car Bodies, Design and Development," was presented at SAE New England Section, March 7, 1950.

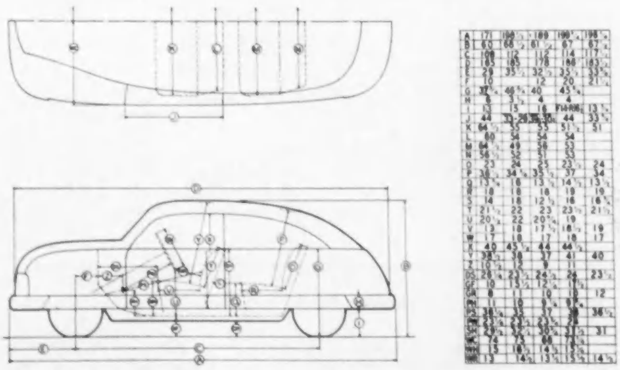




The art department, equipped with such principle dimensions as wheelbase and approximate overall length, width, and height, works up several design studies for consideration. Representatives of management look over these artist's conceptions and make a tentative or partial choice.

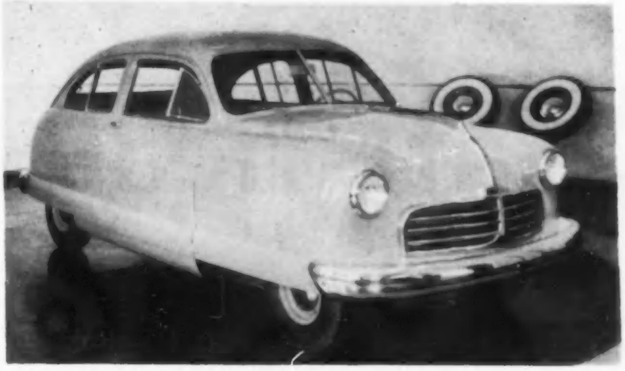


A scale model worker then builds a quarter or three-eighths scale model of their choice. The resulting wood and clay model can be viewed from all angles and altered to suit the designer's or management's ideas of lines, shapes, and design or styling characteristics.

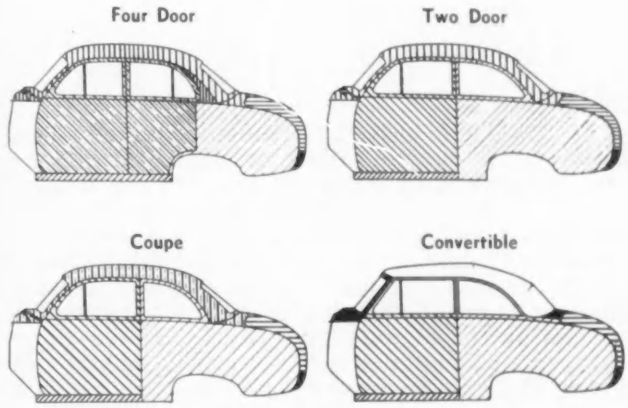


At this stage a careful study is usually made of the important dimensions to be considered in the interior of the body. A chart permits comparison of these dimensions with those of a list of cars in the same general class as the one being designed. Most manufacturers make a blackboard drawing of actual size about this time so that all concerned will have a good idea of the life-size lines and general proportions of the car.

Wood workers in the pattern shop then make a full size mock-up, using such materials as steel, aluminum, and castings. Everything is done to make the mock-up as nearly like the finished car as possible, both inside and outside. (They work from drawings made by draftsmen who take templets from a full size clay model and reproduce them on a large drawing—laying in enough of the construction to determine the thickness of doors, body pillars, and so on.)

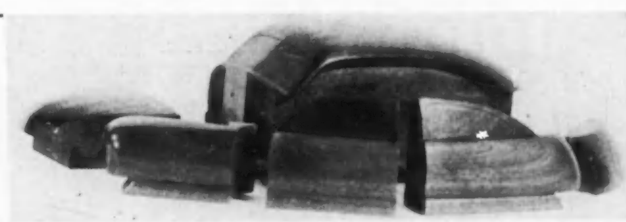


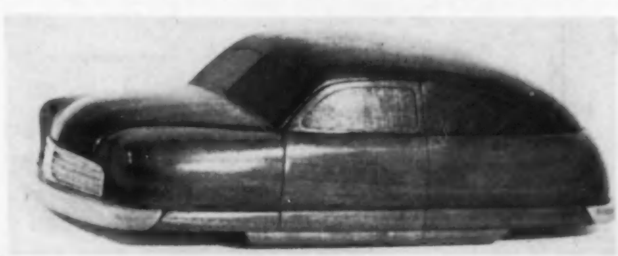
All aspects of the appearance and utility are carefully checked, such as head room, leg room, seat contours, and conditions governing entrance and exit.



Meanwhile, the styling department completes its studies of the other body models of the line. And, by designing wider doors, shorter roofs, and using the same front end, they style the two-door sedan, business coupe, and convertible. The engineering department makes full size sectionalized drafts on aluminum sheets painted white. These drafts, which show every line on the surface of the car, are used by model builders to make templets.

Mahogany die models are made of each part of the body. Outside panels are set up together so that the engineers can check surface contours for highlights and surface blends from one panel to another. These models are then released to the manufacturing department for use in making dies, and so on. Original designing and engineering is finished—hundreds of manufacturing operations will follow before this new creation reaches the consumer.





Statistical Instruments

MOTOR vehicles have many built-in characteristics that can be studied with interest. Of these, however, there are only a relative few that are directly related to the vehicles' behavior on our highways and under traffic conditions. The committee selected for study velocity, acceleration, deceleration, and fuel economy, as being the most basic. Certain values of these characteristics are built into motor vehicles by the manufacturer, and data regarding them can be obtained for individual makes and models of cars. To what degree the driving public takes advantage of what the manufacturer gives them is only a matter of speculation.

The immediate objective of the committee, therefore, was to devise ways and means of studying these four basic characteristics, as to how they are used by the driving public, how this use affects traffic conditions, and how roads and traffic in turn affect their use.

The subcommittee on Instrumentation has designed and built one set of instruments for recording data on the four basic characteristics designated by the committee. Acceleration is not recorded directly, but as two related quantities, namely, engine torque and throttle opening, which are roughly proportional to acceleration.

The four recorders developed to date are contained in cases, which are placed in the test car. Connection between the instruments and the car is quite easily made and consists of certain electrical connections: a tube connection with the windshield wiper vacuum outlet on the intake manifold, a T take-off drive from the speedometer cable, the installation of a contact sector on the throttle, and the installation of the fuel meter in the carburetor gas line. All instruments record their data in the form of numbers on banks of electric counters. The data, therefore, are statistical in nature and can be plotted in the form of graphs or charts.

Fig. 1 is a schematic diagram of the instrument

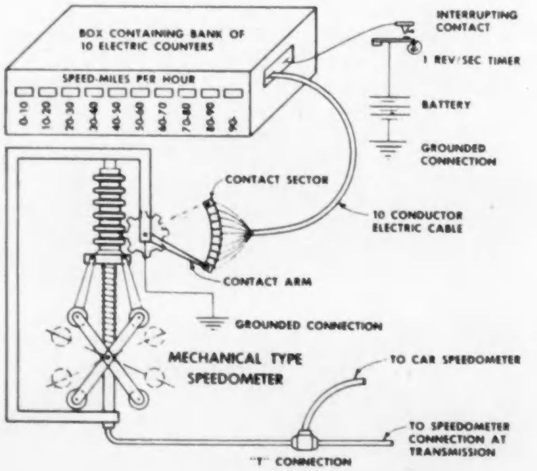


Fig. 1—Instrument for recording velocity

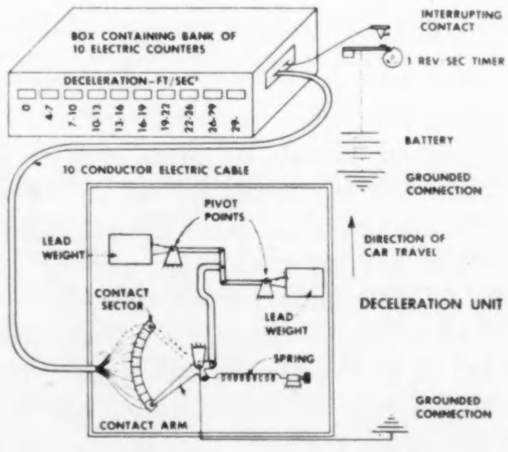


Fig. 2—Instrument for recording braking

Aid in Traffic Surveys

EXCERPTS FROM PAPER BY

T. J. Carmichael, Administrative Engineer, General Motors Proving Ground

and

C. E. Haley, Assistant Traffic Engineer, Phoenix, Ariz.

• Paper, "Study of Vehicle, Roadway, and Traffic Relationships by Means of Statistical Instruments," was presented at the SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 8, 1951.

recording the speed characteristics. The heart of this device is the distributing speedometer seen at the lower part of the diagram. This is a heavy mechanical type of speedometer driven by a T take-off from the regular speedometer cable of the car. The indicating hand of the speedometer is replaced with an arm that sweeps over a sector divided into contact plates, so designed that each one covers a specific increment of speed. Each contact is individually electrically connected to an electric counter. The circuit from the bank of counters is continued to an electric timer, hence through a battery, and finally to the swinging arm of the speedometer, completing the electric circuit through the grounded connections.

Each counter in the speed bank, therefore, represents a range of speed in miles per hour.

At the end of any trip, the number totaled up on any counter represents the number of seconds during the trip that the vehicle was traveling in that

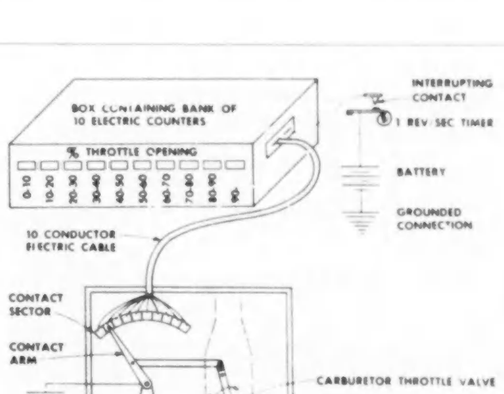


Fig. 4—Instrument for recording throttle opening

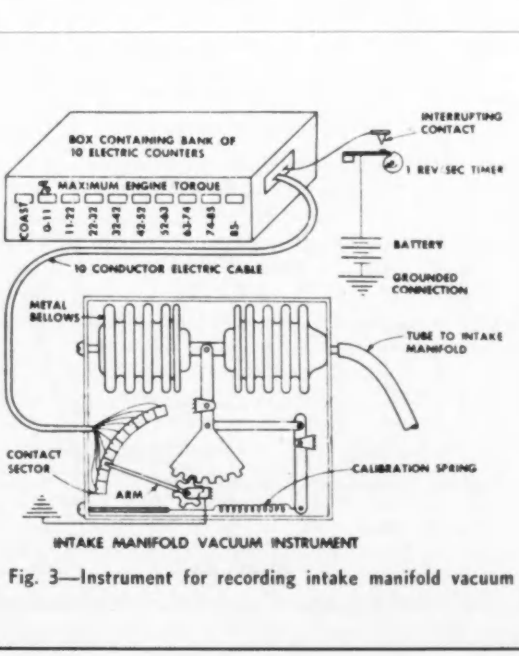


Fig. 3—Instrument for recording intake manifold vacuum

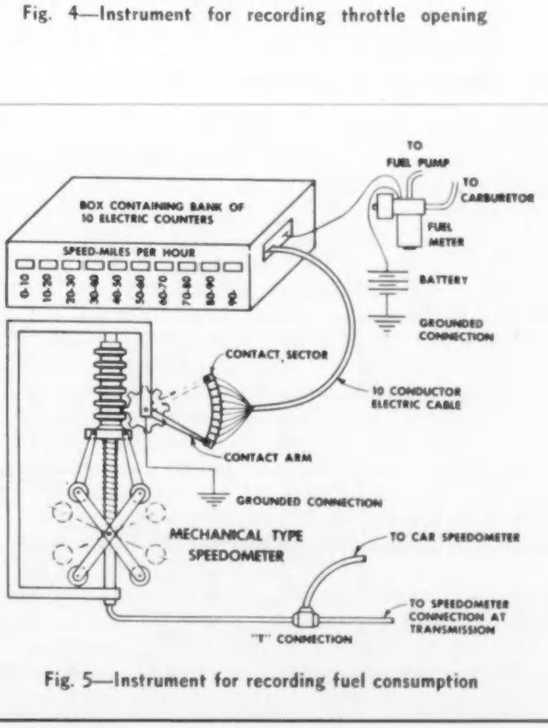


Fig. 5—Instrument for recording fuel consumption

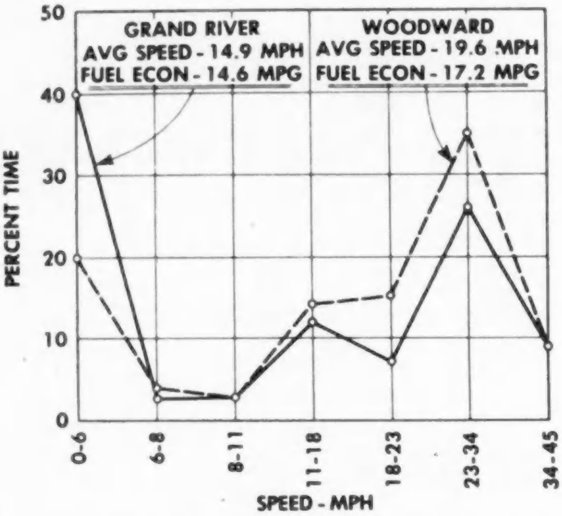


Fig. 6—Speed data for Grand River Ave. and Woodward Ave., Detroit

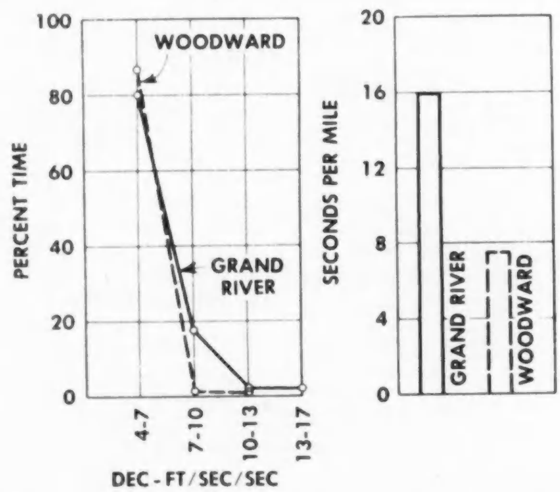


Fig. 7—Braking data for Grand River Ave. and Woodward Ave., Detroit

particular speed range. Data from this instrument are plotted in graphical form, the vertical axis representing per cent of time.

Fig. 2 is a schematic diagram of the instrument recording braking. The heart of this device is a distributing spring-mass decelerometer unit, having as the indicating hand a contact arm sweeping over a sector, as in the velocity recorder. The electrical circuits through the bank of counters and timer are identical with the velocity instrument and need no further explanation. The decelerometer unit itself is an adaptation of the design used for many years in the the General Motors brake machine, which has proved to be very rugged and reliable.

Each counter above No. 1 in this counter bank represents a range of deceleration. The number of counts on any counter above counter 1 in a trip is the total number of seconds that the brakes were applied in the range of deceleration represented by that particular counter. Data are plotted showing ranges of deceleration and the per cent of time of application.

Measurement of Acceleration

We are also interested in the amount and degree which a vehicle is accelerated on a trip. Measurement of acceleration is much more difficult than deceleration, because the range of acceleration varies widely in the different gears of a vehicle, and because the maximum acceleration is a small per cent of gravity. The requirements in a direct-reading accelerometer, therefore, are such that the instrument of necessity becomes delicate and complicated to the point that it is impractical for this type of work. Ways and means were, therefore, sought that would in some more practical manner give us an indirect measure of acceleration. Acceleration in a motor vehicle is brought about by an increase in engine torque, which is roughly proportional to throttle position. In other words, when you wish to accelerate your car, you "step on it." Therefore, a record of the degree of throttle open-

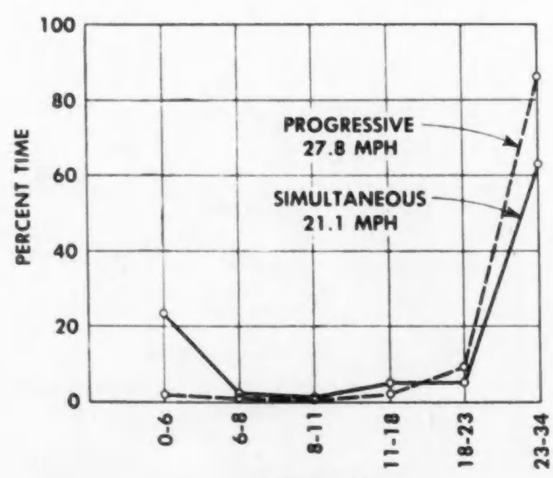


Fig. 8—Speed data—simultaneous versus progressive system

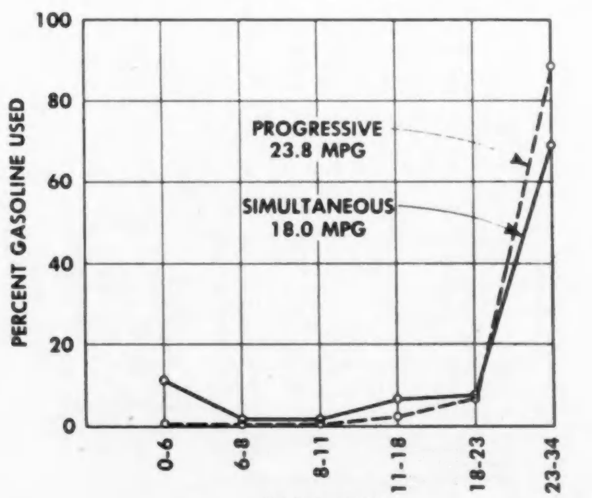


Fig. 9—Fuel consumption data—simultaneous versus progressive system

ing is a rough indication of the driver's desire to accelerate on a level terrain. In hilly terrain this is not true, because of the different throttle openings required to maintain constant speed on different gradients.

Engine torque is also roughly proportional to the differential pressure existing between the intake and exhaust manifolds of the engine. However, the pressure in the exhaust manifold contributes only a small part of the proportionality, so that we can say that the engine torque can be roughly measured by the degree of pressure existing in the intake manifold. The attractive part of this is that it offers a very easy and rugged means of recording the torque or force that is required of the engine to drive the car over a certain trip. There is a considerable difference of opinion in the committee itself as to the desirability of obtaining information by either of the above methods. We have, however, devised instruments for recording these data and are studying the results.

Fig. 3 is a schematic diagram of the intake manifold vacuum instrument. The vacuum device itself is a metal bellows to which is attached a calibrated spring and a swing arm passing over a sector divided into contact plates representing ranges in vacuum. As in the instruments described before, the electrical circuit distributes to the bank of counters and is interrupted by the timing contacts.

Fig. 4 is a schematic diagram of the instrument relating throttle opening with per cent of total time. The basic part of the instrument again consists of a sector having a series of contacts over which sweeps an arm connected with the throttle mechanism, so that each contact represents some degree of throttle opening. The electric circuit is identical with those previously described.

Data from both of these instruments are plotted in the form of graphs, the vertical axis representing per cent of time. In the case of throttle opening, the horizontal axis is in ranges of per cent of throttle opening. In the case of engine torque, the horizontal axis may be in ranges of per cent of engine torque or, in certain cases where a single automobile is used as a test car, torque can be converted into force driving the car. In the latter case, the horizontal axis is in ranges of force.

FIVE years ago the Highway Research Board set up a Committee on Vehicle Characteristics to study the characteristics built into motor vehicles and their relation to traffic problems.

Before the committee could carry out its purpose, it had to set up a Subcommittee on Instrumentation to develop tests and instruments to be used in the study.

After a set of highly experimental instruments was designed and built, they were installed in a 1950 Plymouth and a testing program started to determine the durability of the instruments and the utility of the information they could provide.

The program covered the use of instruments to measure:

1. Differences in the roadway itself.

2. Differences due to drivers.

3. Differences due to changing an urban street from two-way to one-way traffic.

4. Differences due to changes in traffic volume.

5. Differences due to changes in the signal system.

Presented here are the parts of the paper that describe the instrumentation and that discuss the fifth part of the test program, that concerned with differences due to changes in the signal system.

Fuel Economy Recorder

Fig. 5 is a schematic diagram of the fuel economy instrument. The general layout of this device is identical with that of the speed instrument (Fig. 1) except that the fuel economy unit is introduced into the circuit in place of the timing interrupter. The fuel unit is connected in the fuel line of the vehicle between the carburetor and the fuel pump. Fuel under pressure from the pump enters the inner side of a metal bellows, which is displaced against gasoline surrounding it in a metal chamber. This gasoline is forced out of the chamber through the fuel line to the carburetor. The displacement continues until the bellows is stopped by a rigid contact which actuates the electrical circuit, throwing up one number on the counter, and reversing an electrically operated gasoline valve attached to the top of the bellows chamber. The reversal of this valve directs the gasoline from the fuel pump into the chamber surrounding the bellows and connects the fuel line to the carburetor with the inside of the bellows. Flow from the inside of the bellows causes it to contract until it strikes an inner rigid electrical contact. When this occurs, the electric valve is reversed, directing gasoline from the fuel pump into the inner side of the bellows, repeating the cycle. All energy for reversing the valve and operating the counter is taken from the electrical circuit and not from the pressure of the gasoline. Adjustment for calibration is accomplished by positioning the electrical stops. The calibration of the present instrument is 0.001 gal for each cycle. Each number totaled up on the counter bank, therefore, represents 0.001 gal of gasoline used. Since the counts are distributed on the bank according to speed, the fuel economy data are shown as the per cent of the total gasoline used on a trip in the ranges of speed used.

As was pointed out at the beginning of this report, the data obtained from all instruments are in the form of accumulated numbers, each number being the sample of a condition over a short interval. All these instruments could have been designed so as to

draw line charts of the different variables. Since, however, phenomena having to do with flow of traffic vary rapidly over wide ranges, analysis of line-chart recordings would have involved a tremendous amount of calculation. The accumulating type of instruments permits a large number of samples to be taken rapidly and easily and reduces the work of analysis to a minimum.

Signal Comparisons

Speed Data—Test runs were made to compare Grand River Ave., Detroit, with seven other Detroit streets. Grand River is a main radial thoroughfare which carries a volume of approximately 46,000 vehicles a day. It was the only Detroit street on which the simultaneous system of traffic signals was in operation. The traffic on the seven other Detroit streets tested was controlled by the progressive system of signals. The "floating car" testing technique was used during all test runs where traffic was present, and when traffic became light, the posted speed limit was maintained.

On Grand River left turns were prohibited at all times, and parking was prohibited during rush hours. A system of reversible lanes was in effect during rush hours only. Four lanes were used by the predominate flow of traffic, with two lanes used by vehicles traveling in the opposite direction. The 57 signalized positions of the simultaneous system operated on a simultaneous 90-sec cycle: 35 sec red, 51 sec green, and an average of 3½ sec amber. Thus, every 51 sec, all vehicles using the street were forced to stop.

The results of 65 tests show that the average speeds on Grand River were 3 to 5 mph lower than on the other streets tested, and that the percentage of time on Grand River spent standing still was larger than on any other street. The test results also show that the motorists using Grand River exceeded the speed limit, especially when traffic was heavy, but motorists using the other streets tested did not exceed the speed limit.

Fig. 6 compares the speed data at 7:30 a.m. during one test on Grand River and one test on Woodward Ave. For ease in comparison, the percentage of time spent in the various speed ranges is plotted as a line graph rather than as a bar graph. This speed comparison graph is representative of all the tests made during the rush hours. On Grand River the highest percentage of time, 40%, was spent traveling 0 to 6 mph, while on other streets the highest percentage of time was spent in traveling from 23 to 34 mph. The time spent in the 0 to 6 mph range was approximately the time spent standing still, because the test car traveled at 8 mph in third gear with the throttle in the idle position. Therefore, more time was spent standing still than

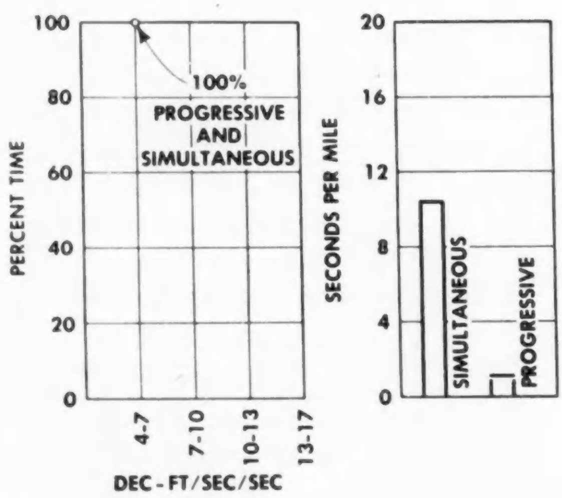


Fig. 10—Braking data—simultaneous versus progressive system

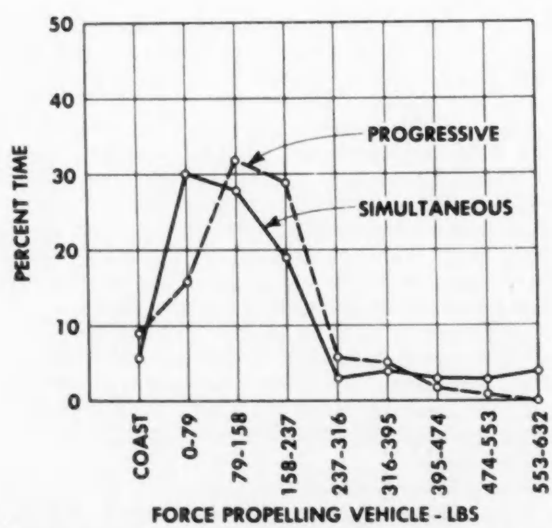


Fig. 11—Force data—simultaneous versus progressive system

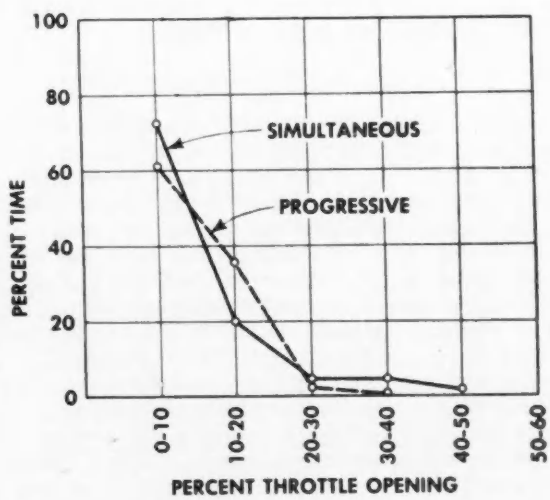


Fig. 12—Throttle opening data—simultaneous versus progressive system

any speed range on Grand River during the rush hours.

Test runs made in relatively light traffic show that almost one-third of the time traveling on Grand River was spent standing still, while the highest percentage of time standing still on the other streets tested was only 9%.

Although the average speed was only 14.9 mph at 7:30 a.m. on Grand River, 9% of the total trip time was spent in the 34 to 45 mph range, (Fig. 6), even though the entire test run had a posted speed limit of 30 mph. At noon, 5% of the total trip time was spent in this illegal speed range, while during the 5:00 p.m. rush, 6% of the time was spent in this range. Thus, the motorists spent more time in the illegal speed range when traffic was heavy than they did when traffic was light. Woodward Ave. was the only street, other than Grand River, on which the traffic traveled in the 34 to 45 mph speed range, but Woodward was posted for 35 mph or faster for about two miles of the 8.8-mile test run.

Fuel Economy—The fuel economy data show a loss in fuel economy due to traffic congestion, whether real, as in the case of heavy traffic, or because of artificial congestion, as in the case of the simultaneous system of traffic signals. The fuel economy was low on Grand River because a larger percentage of the total fuel used was used at the lower speeds. Nineteen per cent of the fuel consumed during tests on Grand River was consumed in the speeds from 0 to 11 mph, while only about half as much, 10%, was consumed in this same speed range, 0 to 11 mph, on the other streets.

The average fuel economy for all runs made in heavy traffic on Grand River was 14.0 mpg, and in heavy traffic the other streets tested averaged 16.7 mpg. In the light traffic, the average gasoline mileage obtained was 16.0 mpg on Grand River and 19.8 mpg on other streets. This loss in fuel economy costs the 46,000 motorists who used Grand River each day almost a quarter of a million dollars each year.

Braking—Fig. 7 is a representative of the braking data obtained. The line graph indicates intensity of braking and shows the percentage of braking time spent in each of the ranges of deceleration, while the bar graph indicates the amount of braking, expressed in seconds of braking per mile. In general, the undesirable and even dangerous rates of deceleration were used more often on Grand River,[1] and the amount of braking generally used on Grand River was twice that used on the other streets. Because the motorists must stop every 51 sec on Grand River, they have to use their brakes almost as much in light traffic as they do in heavy traffic.

Simultaneous versus Progressive System for Grand River Ave.—Prior to June 3, 1950, the simultaneous system of traffic signals on Grand River Ave., Detroit, was in operation 24 hr a day. After this date, a progressive system of traffic signals was placed in operation during the late evening and early morning hours, extending from downtown Detroit for a distance of 5.8 miles. Thus, an opportunity was presented to show directly how well the

Table 1—Gasoline Economy and Average Speeds for Grand River Ave.—Simultaneous versus Progressive Signal System

Simultaneous Signal System	Trip Starts	Direction	Average Speed mph	Fuel Economy, mpg
Southfield to Cass	Midnight	S	20.8	18.2
9.9 Miles	12:40 a.m.	N	20.9	17.8
June 1 & 6, 1950	Midnight	S	21.1	18.0
	12:40 a.m.	N	21.6	18.3
Average			21.1	18.1
Progressive Signal System	**Trip Starts**	**Direction**	**Average Speed mph**	**Fuel Economy, mpg**
Oakman to Cass	Midnight	S	28.3	23.1
5.9 Miles	1:00 a.m.	N	27.8	23.8
June 23, 1950	1:20 a.m.	S	28.3	23.3
	2:00 a.m.	N	27.8	23.9
Average			28.1	23.5

instruments would record the differences between vehicle operating characteristics under the two systems, on the same street. At no time during the tests did traffic hinder the test car. The speed limit of 30 mph was maintained except when traffic lights forced the driver to stop. The only variable in the tests was the signal systems, the same car and driver being used for all tests.

The test results presented in Table 1 show that, during the early morning hours, the simultaneous system of traffic signals permitted an average speed 24% less than the progressive system permitted, 21.1 mph compared with 27.8 mph, and yielded an average fuel economy 24% lower than the progressive system yielded, 18.0 mpg compared with 23.8 mpg. Thus, the simultaneous system here lowered significantly the speed and economy of individual transportation. Figs. 8 through 12 show the results of this before-and-after study on Grand River.

Fig. 8 shows the distribution of time spent in the various speed ranges. The average speed was improved 6.7 mph by the progressive system, and this improvement was due to reducing the time spent standing still (that is, 0–6 mph) by 22%. Fig. 9 shows the speed ranges in which the fuel was consumed. The addition of 5.8 mpg to the fuel economy is highly significant, with gasoline costing about 26¢ per gal. This rise in fuel economy was accomplished by the reduction of the amount of fuel consumed in the lower speed ranges.

While all the braking during both tests was in the deceleration range of 4 to 7 ft per sec per sec (Fig. 10), the amount of braking (represented by the bar graph) was greatly reduced by the progressive system—from 10.5 to 1.0 sec per mile.

Fig. 11 shows the force used to propel the vehicle during both tests, while Fig. 12 shows the percentage of time spent in each 10% increment of throttle opening.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

[1] See Highway Research Board Proceedings of Twentieth Annual Meeting, Vol. 20, 1940, pp. 393–398: "Deceleration Distances for High-Speed Vehicles," by E. E. Wilson.

New Rescue Seaplane Needed by Coast Guard

EXCERPTS FROM PAPER BY

Capt. D. B. MacDiarmid, U. S. Coast Guard Air Station, San Diego

• Paper, "The Seaplane in the U. S. Coast Guard," was presented on April 16, 1951, at SAE National Aeronautic Meeting, New York.

THE Coast Guard faces new problems in rescue and will need improved equipment to cope with them. Arguments are rife on the relative merits of this or that type of rescue equipment, but it is agreed that the fundamental requirements of a good search and rescue vehicle are:

1. Ability to operate in all weather and conditions;
2. Speed—including speed in getting started on a mission;
3. Efficiency as a searcher with lookouts, radio, and radar;
4. Range and endurance;
5. Ability to do a job on the scene of action.

The seaplane excels the surface ship today in speed and search efficiency but trails her in all other needed qualities. New problems in rescue indicate a need for development of a modern rescue seaplane that will meet the other requirements.

The great weakness of the seaplane is inability to land and take-off safely at sea except in daylight and favorable weather. This does not mean that today's seaplane is helpless to operate in other than a calm sea. But the fact stands adamant that it cannot yet operate with sureness and security in many moderate seas; that nearly every open sea landing is based on a calculated risk.

Before the last war trans-ocean passenger transport by airplane was pretty much a novelty. Today traffic is counted in the hundreds of thousands and it continues to increase. And, while the law of gravity holds and human error is a factor, there will be disasters. The fact that the percentage lost will be very small is not a release from this problem for rescue people.

Since future routes with jet transports may be

nearly transpolar (to use or avoid the 100 mph plus jet streams of wind found at high altitudes), rescue operations will demand more speed and efficiency because of the greater shock and exposure casualties forced down on the sea will suffer.

The seaplane of the future, therefore, should have the ability to:

1. Land safely in any but a very bad sea (up to 15 ft high and complex),
2. Ride the sea safely and easily on any heading, maneuvering freely regardless of wind,
3. Take-off from a rough sea with 40 passengers aboard,
4. Cruise economically 2000 miles at 180 knots and 2000 miles at 120–130 knots; escort a jet transport 500 miles at 260 knots at above 20,000 ft; search comfortably at 500 ft at 120 knots,
5. Provide a superior type of airfoil and propeller deicers for possible use in arctic seas,
6. Jettison fuel fast and safely; carry best available radar; carry best possible aids to navigation, instrument, and night flying,
7. Contain a small first aid or operating compartment with proper lights and fixed equipment for medicos; provide litter accomodations for 30 persons, and adequate oxygen from tanks or candles for 50 persons for 6 hr.
8. Provide for bringing passengers aboard from life boats or rafts safely in boisterous waves; and have four efficient search stations—bow and tail, and small blisters port and starboard.

These requirements are very conservative when one thinks in terms of the future. Except for the open sea landing qualities, and small special items which pose no greater problems, they are practically available in aircraft already built—if fuel is substituted for pay load. The open sea landing, surface operation, and takeoff are the nub of the problem. In fact, when that weakness is thoroughly mastered, planes can be refueled from cutters far at sea and will not need the range specified.

The solution to the open sea operation involves:

1. Strength to take racking, pounding and twisting from the sea.
2. Improved lateral stability. (Surely feasible without substantial drag penalty by inflating boots about wing-tip floats while maneuvering on the water.)
3. Slow touchdown speed. (Slots, improved flaps, droop snoot, variable aspect ratio.)
4. Quick deceleration. (Spoilers, water brakes, reverse thrust, retractable step.)
5. Very quick take-off. (Combination of flaps and JATO should do this easily.)
6. Very good aileron, rudder and elevator control at slow speed.
7. Comfort, convenience, and a good view of the sea ahead for the pilot.
8. All especially vulnerable parts such as propellers, flaps and empennage positioned as high as possible.
9. Wing-tip floats to ride in half down—but braced—position while running on the step.

Voices will say the cost in money and talent to develop a modern rescue seaplane is not justified. But a ditched military pilot saved from the sea is worth more than $35,000 in replacement value alone and the morale value to him, his squadron mates, and his family is immense. A few very rich men saved will pay income taxes the rest of their lives that will amortize the cost entirely.

In view of past design and construction progress by American engineers, the technical problems posed are elementary. If they can harness the shattered atom, pierce the sonic barrier, and progress simultaneously in all other aspects of science and engineering, a supine surrender to the new hazards from the sea is unthinkable.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

A very valuable contribution to progress in the field of open seaplane operations has been made by recent (and continuing) studies of sea wave phenomena by oceanographers. Today no other phase of the seaplane design problem—as far as suitability for open sea work is concerned—is more important than acquiring a reasonable understanding of the dimensions, forces, forms and velocities to be met on the sea's surface.

The first step is flat recognition that the sea's surface is rarely represented accurately by a scaled up Japanese print or picture of Prospect Park Lake. A sea wave is a resultant of wind force, duration, and area over which that wind was effective. And local disturbances commonly overlay a substantial swell system or systems which originated in other storm areas hundreds or thousands of miles away.

Obviously, then, open sea seaplane testing to be thorough cannot be accomplished in a day or two in just one or any sea locality.

Development of a Modern

TO arrive at the final design of the new Ford dynamometer laboratory required passing through three major steps, namely, construction of: (1) a full size wooden mockup of a typical dynamometer room, (2) an operating pilot dynamometer room, and (9) the actual dynamometer laboratory.

The mockup furnished preliminary information regarding space requirements and so forth, and made it possible to build an operating pilot room, which provided specific data for making final design decisions.

The Wooden Mockup

Studied in the full size wooden mockup were room dimensions, ventilation, lighting, and color scheme, and the location of operating equipment.

The formerly agreed on module dimensions of a room 18 ft wide by 30 ft long with a 13 ft high ceiling were used in building the mockup. Placement in the room of full scale wooden models of typical dynamometer room equipment showed that these dimensions were well proportioned for two-engine stand operation. And sufficient space was still available for additional equipment or for any work pertaining to engine and transmission testing.

A recirculating system was used wherein the incoming air was forced into ducts above the ceiling, then down into the room. The outlet air-grilles, located directly beneath the continuous slot, were placed at each end of—and between—each bedplate. The air then entered a duct below the floor grilles which led to the inlet of exhaust blowers.

The basic idea behind the complete design involved a system to utilize a blanket or screen effect around the engine and dynamometer bedplates. In this way the velocity of the air would discharge the heat and any gaseous fumes, given up by the engine and dynamometer, directly into the exhaust outlets. This system tends to keep the dynamometer room free of fumes and excessive heat, the operator breathing in fresh air, and the ceiling and walls cleaner for a longer period of time.

The minimum lighting requirement for the dynamometer room was specified by Ford engineers to be 50 ft-c around the general working area and at the height of the operator's control desk. The final design called for a total of 12 fluorescent light fixtures, distributed six to a side and mounted flush with the ceiling. This system provided sufficient light at the specified areas.

The original color scheme used for the wooden mockup consisted of gray walls, white ceiling, and a red tile floor.

Pilot Dynamometer Room

The pilot dynamometer room, see Fig. 1, was constructed as a logical step in the development of the dynamometer laboratory. Construction of this room served three main functions:

1. It acted as a proving ground for evaluating under all conditions the various types of well-known and reliable test equipment.
2. It answered the need for additional test facilities.
3. It provided data for making final selections of acoustical wall and ceiling panels, dynamometer room basement, the dynamometer and engine foundation base, the major and supplementary test equipment, and the fuel supply, water cooling and oil cooling systems.

The first engine was tested in the pilot dynamometer room before the wall covering had been installed. This test was made to obtain sound level readings to be compared to those obtained after the installation of acoustic paneling. Sound level tests conducted after installing the acoustic paneling showed that it reduced the noise in loudness units by 50 to 70%, depending on the sound level. (See Fig. 2.)

The paneling was constructed of a perforated metal surface backed by sound-insulating material. A light blue-green color was selected for the wall panels because it was easy on the eyes and had a high lighting factor, with complete absence of glare. In addition, the cleaning problem in the room was reduced by using baked enamel paint on the walls and ceiling.

A full basement is located directly under the pilot dynamometer room. It contains a dynamometer motor-generator set, electronic control cabinet, the aqua fuel system, and the jacket water and oil heat exchangers with their respective lines and counters. This equipment was installed in the basement to conserve floor space at the dyna-

Dynamometer Laboratory

EXCERPTS FROM PAPER BY

C. L. Bouchard, Manager, Building and Facilities Department, Ford Motor Co.

H. Oxley, Ford Aircraft Engine Division, Ford Motor Co.

• Paper, "Development of a Modern Dynamometer Laboratory," was presented at SAE Passenger Car, Body, and Materials Meeting, Detroit, March 8, 1951.

mometer room level, to reduce the room noise, and to provide a room as free as possible from service equipment and other obstructions.

The engine and dynamometer bedplates and the dynamometer itself rest on a hollow base composed of approximately 50 yd of concrete. The bedplates are grouted in the base, and the combination is isolated from the main as well as the basement floor by a mastic joint. Engine and dynamometer vibrations, therefore are absorbed in the base. Within the hollow portion of the base a number of pit sprays, made from pipes with laterally drilled holes, spray water on the walls. This keeps them clean and aids in moving any spilled oil or gasoline via the pit weir to an oil separator. Also located within the base are the dynamometer exhaust pipes that lead to the exhaust blower, the thermocouple conduits leading from the engine bedplate to the potentiometer, the water inlet and outlet pipes, and the oil inlet and outlet pipes.

The dynamometer, which is shown in Fig. 3 is a direct-current cradle type, capable of absorbing 200 hp or of delivering 150 hp up to speeds of 6000 rpm. It is used in conjunction with a motor-generator set connected to a 440 v, 3 phase circuit. When the dynamometer is used for motoring, the current is drawn from the 440 v line. When the dynamometer is absorbing power, the current thus generated goes through the motor-generator set, which then becomes an alternator in the power line. (This constitutes a power recovery dynamometer.)

Three bedplates were used in the pilot dynamometer room, allowing a space for the exhaust grilles between the engine and the dynamometer bedplates and at the end of each engine bedplate. The bedplates and the grilles were installed on the longitudinal center of the room, with the bedplates being mounted within approximately 1/8 in. of the the floor level. The dynamometer was mounted on the center bedplate so that an engine could be connected at either end. This arrangement permits an interruption to an engine test without the inconvenience of removing the engine or having the dynamometer remain idle while the engine is being worked on. It is also possible to install a second engine while the first engine is still completing a test. The top sides of the bedplates have T slot

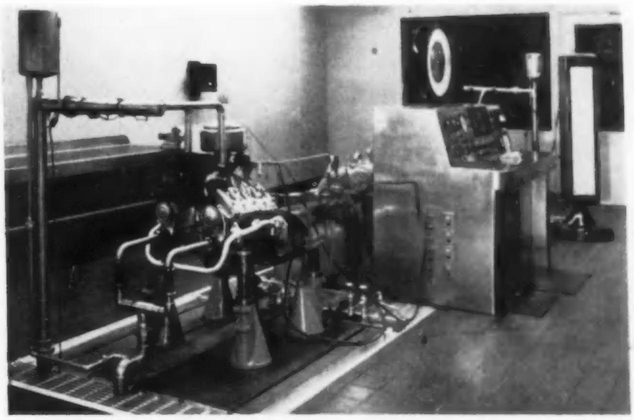


Fig. 1—The pilot dynamometer room, constructed as a logical step in the development of the new laboratory

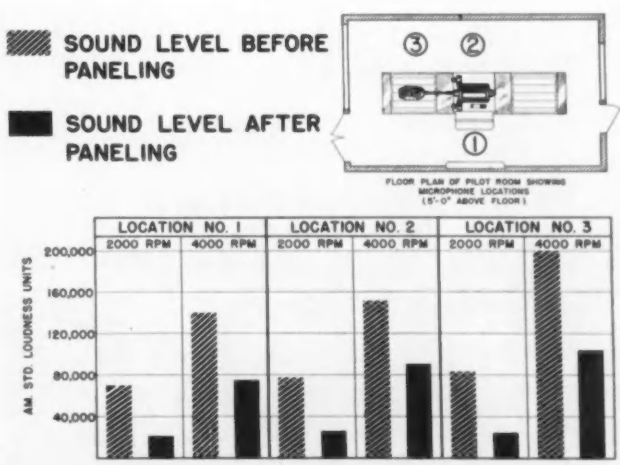


Fig. 2—Bar graph of sound measurements made before and after insulating the pilot dynamometer room

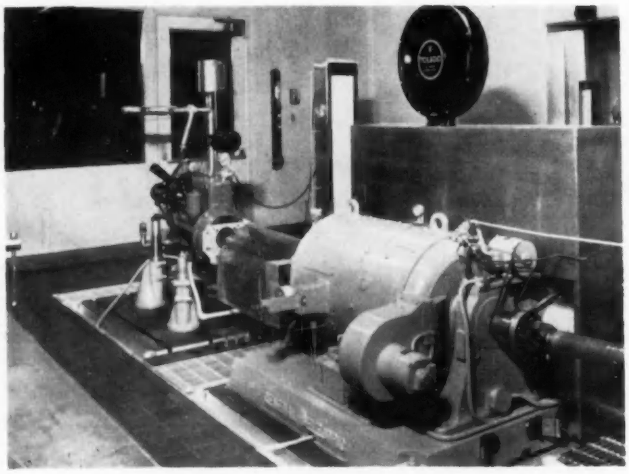


Fig. 3—Direct-current cradle type dynamometer used in the laboratory

Fig. 4—Control desk, mounted adjacent to the dynamometer, contains manual controls and necessary operating instruments

Fig. 5—Recording instrument panel is located directly behind the control desk

grooves and are equipped with side gutters and drain holes. The side and end gutters were eliminated when the bedplates were made for the new building because they created unsafe footing and were dirt collectors.

The control desk, as pictured in Fig. 4, is mounted adjacent to the dynamometer and contains the manual controls and necessary operating instruments. Built of stainless steel, this desk houses most of the small electrical equipment, such as relays and regulators. These instruments are readily accessible through two large doors under the writing shelf or through the back of the desk.

The main instruments included in the control desk are:

1. The chronotachometer.
2. The dynamometer operating controls.
3. Two pressure gages.
4. Air temperature gage.
5. Automatic fuel scale dial and its operating lights and buttons.
6. The dynamometer start-stop buttons.
7. The motor-generator set start-stop buttons.
8. The dynamometer ammeter and voltmeter.
9. A series of indicating lights which tell the operator when all the fans and other operating equipment are turned on.
10. Outlet fittings for pressures.
11. Electric receptacles for connecting the electronic instruments.

A recording instrument panel, shown in Fig. 5, is located directly behind the control desk and partially recessed into the wall. The instruments, flush-mounted on a stainless steel surface, are: two electronic potentiometer controllers for water and oil temperatures, an electronic strip chart potentiometer—capable of recording eight different temperatures, a single record electronic strip chart potentiometer for use with the automatic oil consumption instrument, and fuel scale and fuel rotometer.

The speed indicator is a chronotachometer used chiefly for engine testing. It consists of three instruments: an indicating tachometer, a revolution counter, and an electric timer. The tachometer and counter are driven by the dynamometer through a self-generating transmitter and receiver, and indicate directly in engine revolutions.

A flowmeter and an automatic fuel weight scale are used for fuel measurement. The fuel flowmeter is used for indicating fuel flow during testing, and the weight scale is used for weighing a unit amount of fuel over a unit period of time. These two methods of measurement are not used in conjunction with each other. The fuel flowmeter is cut out of the system by a solenoid valve when the fuel scale starts operating. It has been found for accurate carburetor development and other tests—where fuel measurement is the criterion—that a fuel scale is desirable.

A traveling bridge crane with a one-ton capacity chain hoist is installed in the pilot dynamometer room. This type of crane has the ability to span the complete area in the room, and gives more accurate control for handling engines than electric or air-operated hoists.

An aqua type fuel system was installed which uses water pressure to propel and control the flow of gasoline. (See Fig. 6.) The water and fuel paths

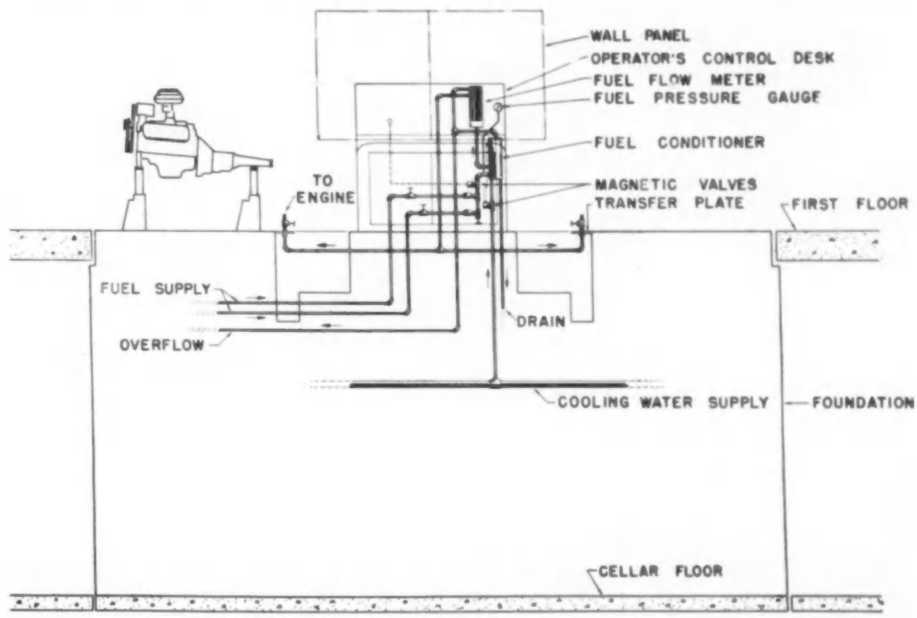


Fig. 6—Aqua type fuel system uses water pressure to propel and control the flow of gasoline. The water and fuel paths are separate except at the storage tank where the two fluids are combined

are separate except at the storage tank where the two fluids are combined (but kept apart by their different densities). This arrangement works satisfactorily, provided a safe method of applying pressure to the fuel is used.

The water-cooling system is installed on a bench in the basement located directly below the operator. (See Fig. 7.) Utilizing a heat exchanger instead of a mixing tank, this closed system uses a controlled amount of city water to cool the jacket water of the engine. The jacket water, once the operating temperature is reached, is controlled by means of electronic instruments that operate a modulating cold water valve. A small tank is necessary to take care of expansion and to maintain normal pressures in the water jackets. Copper tubing is used to eliminate rusting and to provide a low friction factor.

The oil-cooling system is composed of an external pump (5 gpm), heat exchanger, external filter, and a control valve. Oil is taken out of the pan of the engine and pumped through a filter, then through the heat exchanger and returned to the engine. The cold water supply for cooling the oil in the heat exchanger is regulated by a thermocouple temperature control and controlled by a gradually opening and closing valve. The external pump and

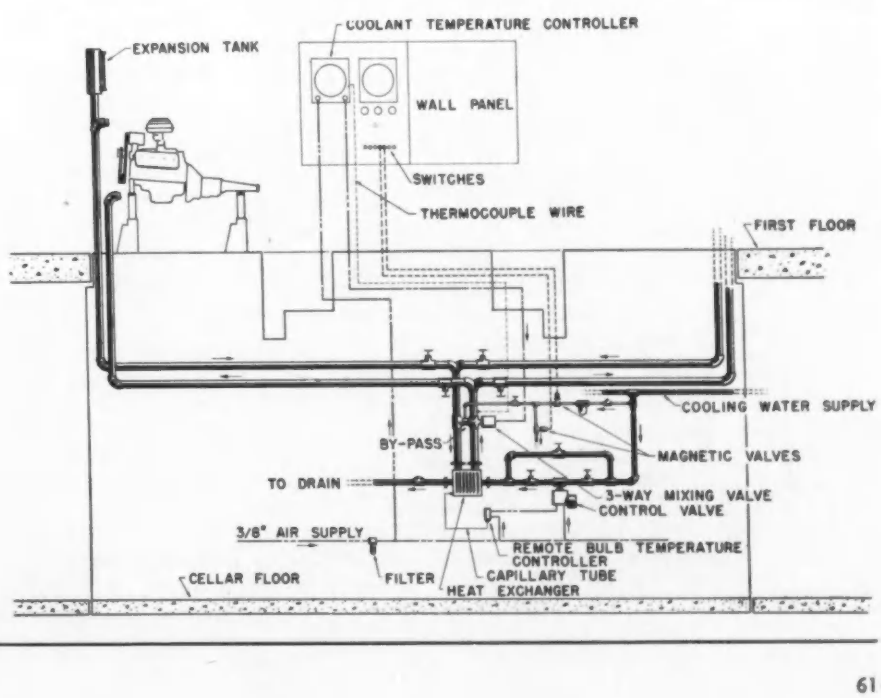


Fig. 7—The water-cooling system uses a heat exchanger instead of a mixing tank. A controlled amount of city water cools the jacket water of the engine

motor, heat exchanger, filter, and the controller are located in the basement. The oil-cooling system is controlled by two valves which select the inlet and outlet lines on either end of the dynamometer. (See Fig. 8.)

The Dynamometer Laboratory

These points were given careful consideration in planning and designing the new laboratory.

1. Arrangement of the building in general for maximum operating efficiency.
2. Good maintenance conditions.
3. Good working conditions for the test operators.
4. Personnel safety, especially that of the test operators.
5. Efficient engine and equipment handling.
6. Flexibility of office space for the test engineers.
7. Instrumentation design in the test rooms for maximum convenience in taking data.
8. Installation of the most modern testing equipment to facilitate taking data rapidly and accurately.
9. Adequate storage space for engines and testing equipment.
10. Provisions for handling and storing a variety of experimental and standard fuels.

A number of studies were made in developing the final size, shape and appearance of the dynamometer building. The final plan is for a building in the form of a cross, with a gross floor space of 230,000 sq ft, having four wings and a central core. (See Fig. 9.) This plan was chosen since it provided a minimum distance to be traveled daily by test personnel between the test rooms and the office wing. The forward or central wing of the building will be used as an office wing; the other three wings will house testing rooms.

The design of the building provides good sound control with respect to the office and operation wings. There will be little if any noise transmitted from the test wings into the central core of the building and forward into the office wing. All the test rooms and corridors are fully sound-treated. The walls and ceilings are covered with perforated metal, interlined with blankets of rock wool. The rooms are separated by 8 in. thick cinder block walls, plastered on one side with a hard cement plaster to prevent noise transmission from one room to another.

In addition to the office space, the completed laboratory will contain:

1. 26 standard performance rooms. (See Fig. 10.)
2. Six endurance test rooms, consisting of:
   a. Four rooms with 200 hp inductors
   b. One room with a 600 hp inductor
   c. One room with a 1000 hp inductor
3. Two transmission test rooms. Fig. 11 shows the general room arrangement. Each room contains a 250 hp electric dynamometer input and 600 hp output inductor. Of special note is the transmission head stand which can be rotated through 180 deg to simulate reverse drive conditions.
4. One carburetor test room containing two flow benches.
5. Two axle testing rooms—one for passenger car axles and one for heavy duty axles. Each room contains:
   a. One 300 hp input electric dynamometer
   b. Two 150 hp output electric dynamometers

The heavy duty axle test equipment is rated the same as above. However, the higher torques required are obtained by using gear boxes.

6. One tractor belt test room. Complete tractor performance test data can be obtained by belting

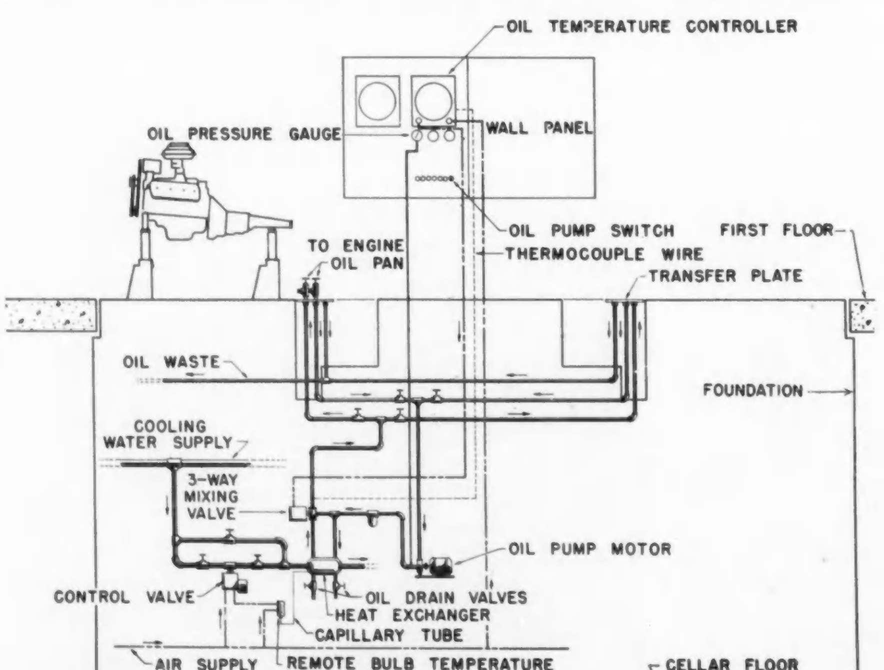


Fig. 8—The oil-cooling system is composed of an external pump, heat exchanger, external filter, and a control valve. These function to cool the oil taken out of the pan of the engine

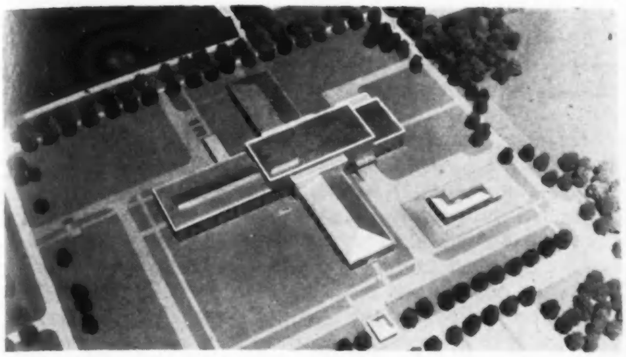


Fig. 9—Scale model of completed dynamometer building

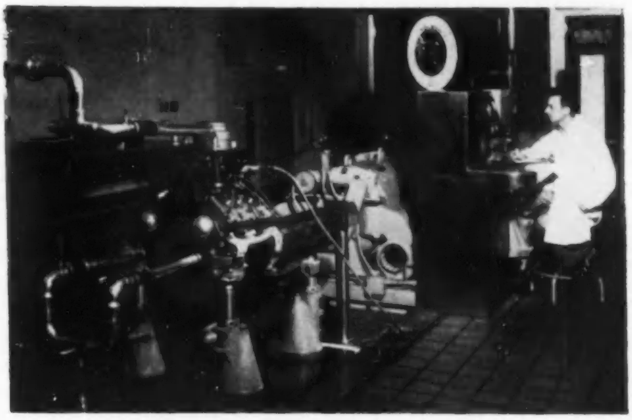


Fig. 10—General room arrangement of the 26 standard performance rooms in the laboratory

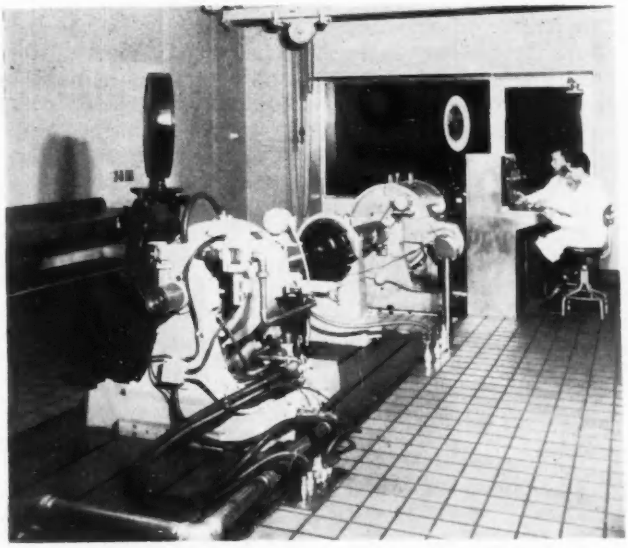


Fig. 11—General room arrangement of standard transmission test room

Fig. 12—A full basement is provided under the building through which all services are routed

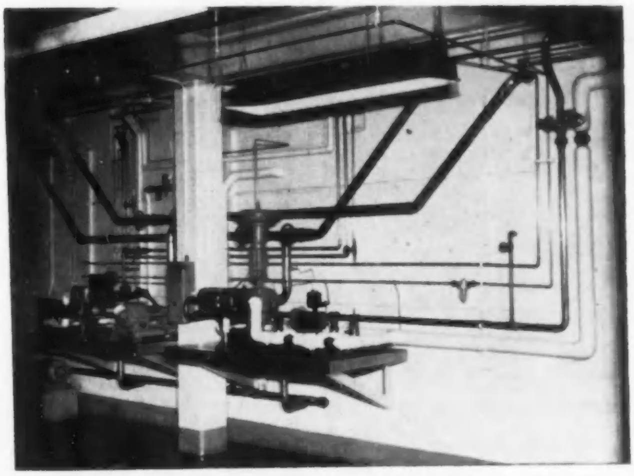


Fig. 13—There is adequate space for maintaining the oil cooling and water cooling systems

the tractor to the 125 hp electric dynamometer located in this room.

7. Two chassis test rooms. A pair of chassis dynamometers are installed in the rear wing of the building. These dynamometers are of the conventional type. However, they are so arranged end to end that is is possible to connect them to one set of chassis rolls when large torques must be absorbed.

8. Bench test room for engine component testing, consisting of 25 units for isolation tests of engine parts, accessories, and so on.

The central core of the building above the first floor level contains all the heating, ventilating, and air conditioning equipment for the four wings.

The operations superintendent's office is located in the central core at the intersection of the two main corridors. This office will contain a switchboard which will make it possible to communicate directly with the operator in any of the 40 different test rooms. It will also be possible to contact all rooms simultaneously to locate a particular individual. There will be no intercommunication between rooms.

In the central core of the building an elevator is provided which travels from the basement to the ventilation equipment in the upper level. It is a combination passenger and freight elevator.

Flexibility of office space for the test engineers was accomplished by using movable metal partitions, easily adjusted to suit varying requirements. Special floor openings and removable floor plates and wall panels are provided to run the various services to all areas in the building. These features make it possible to change from office to laboratory space with a minimum of loss of time and expense.

A full basement, see Fig. 12, is provided under

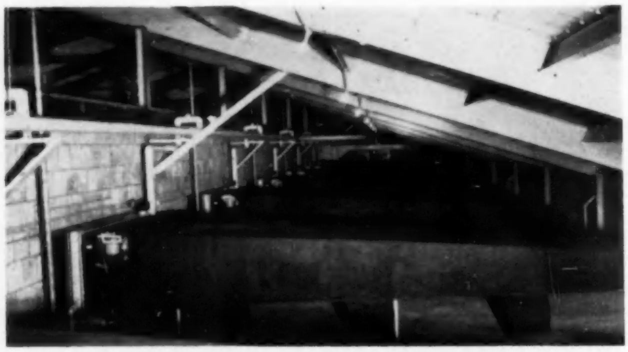


Fig. 14—Branch supply ducts for each test room

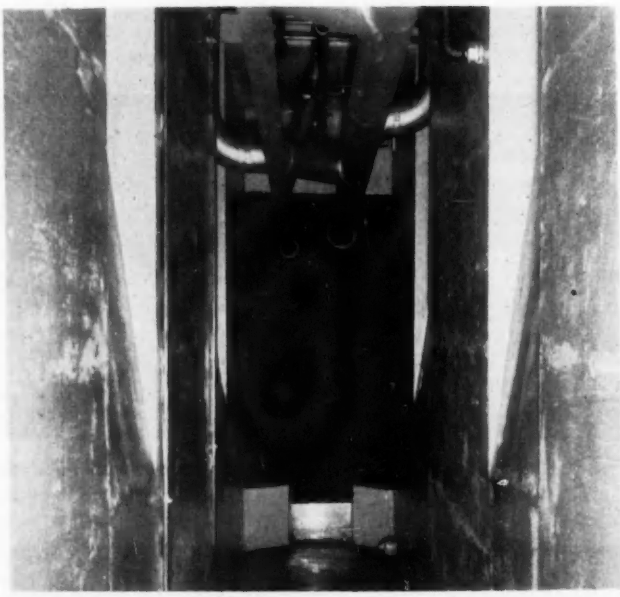


Fig. 15—When testing a complete vehicle exhaust system, the tail pipe and muffler project into the hollow foundation under each test room

the building through which all services are routed. The basement contains among other things, the electronic control cubicles for the dynamometers, the motor-generator sets, the rotary power amplifiers, and the oil and coolant systems for the test rooms on the first floor. Fig. 13 shows that there is adequate space for maintaining the oil and water cooling systems. In addition to these services, locker facilities and a suitable lunch room are furnished for the laboratory personnel.

A central system of ventilation with supply ducts from the core of the building to all rooms was chosen instead of separate supply fans located at each room. It was felt that operating and maintenance and initial costs would thus be lower.

The attic above the test rooms contains the ventilation supply ducting. A main tunnel runs through the center of the attic, with branches leading to the 16 test rooms in each wing. Fig. 14 shows there is ample space for ease of maintenance of heating booster coils, dampers, and the automatic room temperature controls connected with each test room.

The ventilating sequence used in supplying the test rooms is:

1. Fresh air intake
2. Bird screen
3. Plenum chamber
4. Automatic damper
5. Dust filters
6. Heating coils
7. Supply blowers
8. Central supply duct
9. Tempering coil at the entrance of each supply duct
10. Manual damper in branch duct
11. Four vertical ducts (each duct has a manual damper)
12. Plenum chamber over the test room
13. $1\frac{1}{2}$ in. wide continuous slot. (The width of the slot can be manually controlled on about 2 ft long sections.)

Pilot dynamometer room tests indicated that an

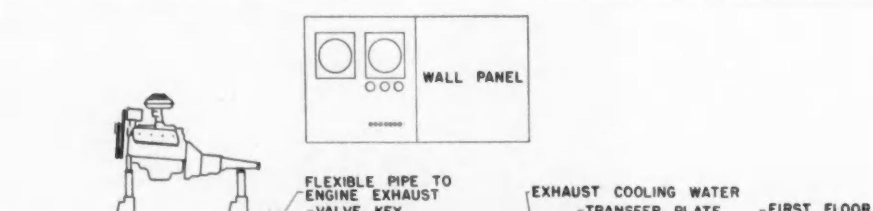


Fig. 16—Schematic diagram of engine exhaust system. Chances of explosion are minimized by introducing a small percentage of bleed air into the blowout valve to dilute explosive mixtures

air flow of 5000 to 8000 cfm during hot summer days was not in the comfort zone for test operators. A study showed that it would be more economcial to supply each room with approximately 9000 cfm of refrigerated air, cooled 12 or 15 F, rather than to supply approximately 15,000 cfm of non-cooled air. The cost of the refrigeration machinery, including the coils, is more than offset by the savings effected in smaller duct and fan sizes, and lower power costs.

A central exhausting system is located in the core of the building with branch exhaust ducts running from each of the test rooms.

The room exhaust air passes through grilles in the bedplate and down into the hollow foundation, where it passes through a water-fog spray. It then leaves the pit and flows through a large tunnel up to exhaust fans in the core.

When it is necessary to test a complete vehicle exhaust system, the tail pipe and muffler project into the hollow foundation, see Fig. 15, and exhaust into the pit. When the as installed exhaust system is not required, the exhaust gas is connected through a seal from which water overflows and mixes with the gases. It then passes directly into a 6 in. steel pipe which connects into a 24 in. engine exhaust main. A blowout valve, 24 in. in diameter, is provided at one end of the main to permit an explosion to take place without rupturing the pipe or damaging any equipment. A small percentage of bleed air is introduced at the valve to dilute any explosive mixtures which may accumulate in the exhaust pipe; thus the chance of explosion is minimized. A blower, mounted in the exhaust line, expels the exhaust gases at the roof level. (See Fig. 16 for a schematic diagram.)

Since the test operators work in the most hazardous locations, their safety was given utmost consideration in the design of the laboratory. The downflow ventilation system, entire room construction with non-inflammable materials, emergency fuel shutoff valves, and use of safety guards on equipment are a few of the measures taken to promote safety.

It was decided not to use the translucent glass covers (used in the pilot room) for the standard test rooms. Instead an egg crate baffling system, using a total of 40 tubes, was adopted. (See Fig. 17.)

The control desk was designed to contain all the instruments which indicate the test data to be recorded. The operator, therefore, is not required to turn around and take data from a wall panel behind him.

The desk in a standard engine test room contains the same instrumentation as in the pilot room with these exceptions:

1. Two pressure gages added.
2. Air temperature gage replaced by 24 point indicating pyrometer.
3. Automatic fuel scale controls eliminated.
4. Control buttons and indicating lights for the motor-generator set and other operating equipment moved to the wall panel.
5. Fuel rotometer moved from the wall panel to the control desk.
6. Dual tube manometers added to desk.

All engines are mounted on four specially designed, conically-shaped, adjustable screw jacks. The jacks are fitted with a universal ball, adjustable type of mounting bracket, which will adapt itself to any angle necessary for mounting the various model engines. The screw jacks create little or no obstruction at the bedplate level, making it easier to maintain and clean the bedplates.

The laboratory is equipped with a suitable loading dock and receiving room. The engines on universal dollies, developed specially for this purpose, are accepted at the receiving dock. The dollies (see Fig. 18) are able to take not only Ford engines but competitive engines as well, with a minimum of adjustment. Each engine has its own dolly, and it never leaves the dolly enroute to or from the test room.

Temporary storage space is provided for in the central wing of the building, adjacent to the receiving department. Engines are stored there until they are ready for test or shipment back to the assembly and tear-down area.

In the interest of safety, a separate fuel house is built approximately 100 ft away from the laboratory. It contains the distribution rack which provides a means of connecting the engine test rooms to any of various fuels. The main storage system used is a water flotation type with the tanks buried in the ground next to the fuel house. All the air from the fuel house is exhausted either at the basement or first floor level to make certain that gasoline vapors will not collect or pocket in the low spaces. The fuel lines are made of hard-drawn copper tubing and are located where they are accessible for maintenance and inspection.

(Paper on which this abridgement is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, and 50¢ to nonmembers.)

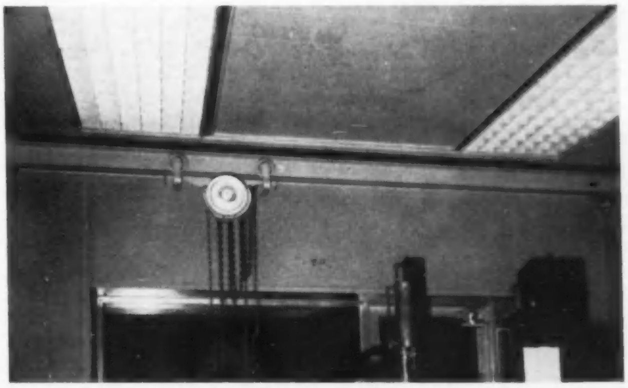


Fig. 17—Egg crate baffling system for the lights—used in all test rooms

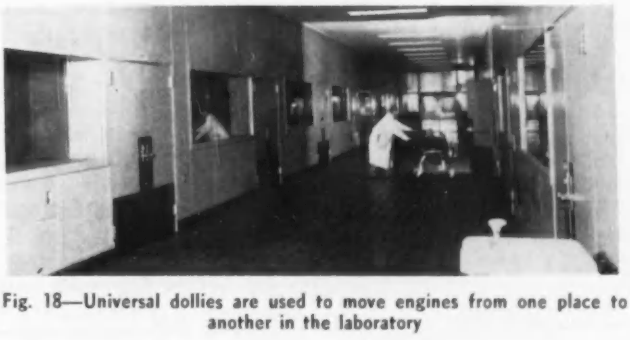


Fig. 18—Universal dollies are used to move engines from one place to another in the laboratory

Third in LPG Series

This is the third article in SAE journal's series on liquefied petroleum gas as a motor fuel.

Digests of papers on the subject by Leonard Raymond, F. E. Selim, and R. C. Alden have already appeared. Fourth and last in the series will be a digest of the paper by M. J. Samuelson.

Carburetion

USE of liquefied petroleum gas as a motor fuel requires special carburetion equipment.

Two carburetion systems have been used, one the liquid withdrawal system and the other the vapor withdrawal system. The former has generally been more satisfactory, although more expensive in first cost.

Liquid Withdrawal System

The liquid withdrawal system is a method whereby liquid fuel is taken from a permanently mounted LPG fuel tank on a tractor, bus, or truck or a similar tank mounted on skids for use with power unit engines. Fig. 1 shows an LPG tank at the left a little more than half full. By means of a dip-tube arrangement, the liquid valve at the top will allow liquid fuel to be forced by tank pressure up and over into the liquid fuel filter. From the fuel filter, the liquid fuel goes on to what is called the high-pressure or first-stage regulator.

The first-stage regulator reduces tank pressure of the fuel to some more satisfactory handling pres-

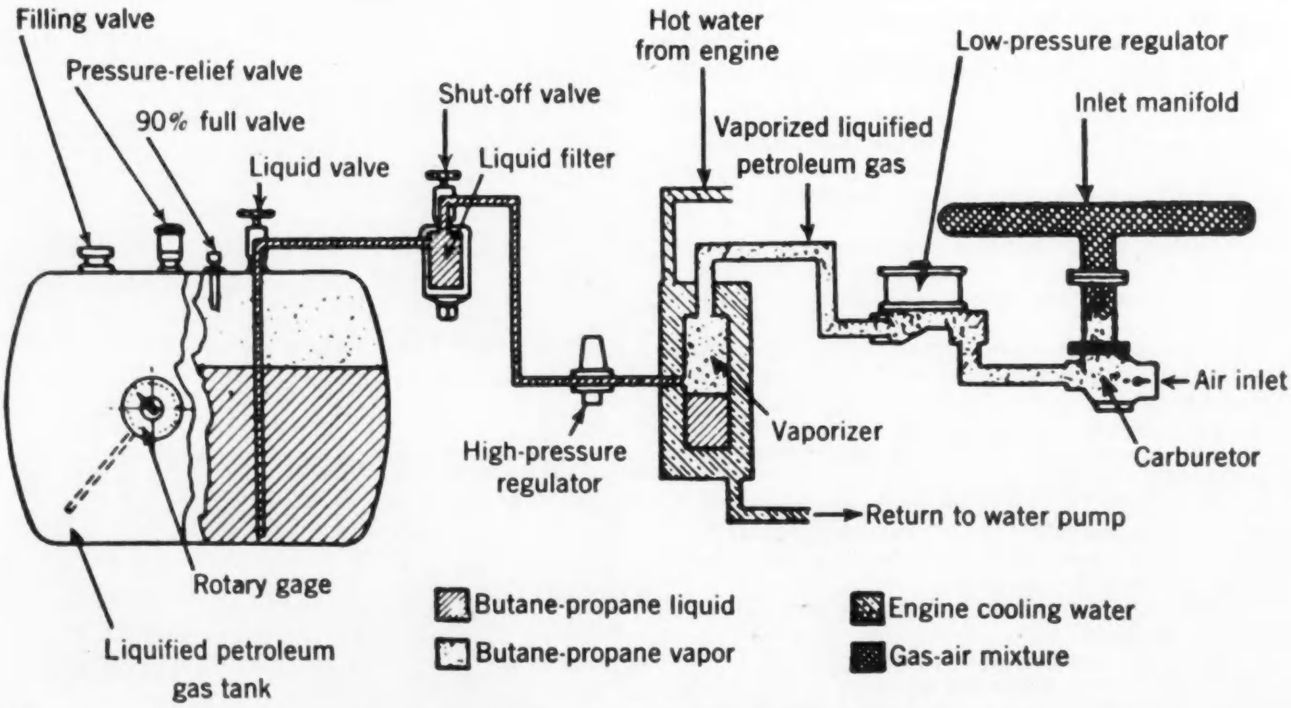


Fig. 1—Flow diagram for butane-propane fuel engine application

Equipment for LPG

EXCERPTS FROM PAPER BY

A. J. St. George, Ensign Carburetor Co.

• Paper "Engine and Carburetion Equipment Requirements for Liquefied Petroleum Gas Fuel" was presented at SAE Annual Meeting, Jan. 8, 1951.

sure, ranging anywhere from 4 to as high as 12 or possibly 15 psi depending upon the particular make of equipment being used. From the high-pressure regulator, the fuel passes into the vaporizer proper where the fuel is vaporized by heated water from the cooling system of the engine.

From the vaporizer, gaseous fuel is passed into the final or low-pressure regulator, sometimes called a fuel metering regulator. It should be noted that the fuel from the vaporizer goes into the low-pressure regulator at whatever pressure the first-stage regulator has been set to discharge. From the low-pressure regulator, the fuel goes into the carburetor at some pressure below atmospheric. In the carburetor, the fuel is mixed with air and drawn into the engine.

The liquid butane-propane filter performs somewhat the same function as the well-known gasoline filter widely used in connection with gasoline carburetors. It is intended to remove tank scale or scale and dirt from the lines and fittings as well as any solid matter that may be present in the fuel itself. To prevent the passage of undesirable foreign matter into the first-stage and second-stage regulators, a fine Monel metal screen is inserted in the liquid fuel inlet connection to the first-stage regulator.

The primary regulator reduces tank pressure down to the range of from 4 to as high as 15 psi, depending upon the specific make of regulator. In actual practice, the first-stage regulator is built into the vaporizer, and thereby external means of connecting the two are eliminated and greater compactness is obtained.

The pressure reduction that takes place at the first-stage regulator involves an initial expansion of the fuel. Some of the liquid butane or propane is vaporized at the first stage of pressure reduction, and it is this vaporized fuel which makes it possible to start the engine in warm or mild weather with liquid fuel being taken from the supply tank. In cold weather, it is advisable to take vapor from the supply tank for starting and running during the initial warmup.

The fuel from the first-stage regulator is discharged into the vaporizing coil, which is surrounded by water from the cooling system of the engine. Generally, the first-stage regulator valve is also water-jacketed to prevent freeze-up. These two devices then accomplish the change in state of the fuel for easier handling and control of its metering.

From the vaporizer, the fuel passes into the second-stage or metering regulator. This regulator is actuated by suction from the engine when the engine is being turned over for starting or when the engine is already running. This suction from the engine opens the final fuel regulator sufficiently to allow fuel to pass to the carburetor and into the engine. The volume of fuel passed by the regulator will depend upon the throttle opening in the carburetor.

The carburetor is a mixing device for mixing the butane or propane vapor with correct volumes of air. The types most generally used employ a removable venturi arrangement so that proper venturi size can be applied to fit engine requirements.

Both the regulator and the carburetor are designed to work together. One is useless without the other. Together they must produce automatically and instantly the correct air fuel ratios for every engine demand. The requirements for mixing and proportioning of the fuel and air have generally been pretty well met by the different LPG carburetors now on the market.

There have, however, been considerable differences in the arrangements provided for starting. It appears now that the picture has finally resolved itself into two distinct types: One embodies the use of a manual or electrically operated primer, and the other embodies a separate fuel metering system built into the carburetor so that positive control of the air-fuel mixture required for starting is provided. This latter type is so designed that a full closing of the choke is required in order to cut out the main fuel metering system and cut in the special fuel metering system for the starting of the engine. The starting fuel system has its own fuel adjust-

ment so that the fuel required to start and run the engine with the choke closed can be metered to provide the proper air-fuel mixture ratio. The air going into the engine with the choke closed would naturally be that volume which passes through a hole in the choke disc provided for that purpose. After the initial adjustment of the starting system has been made, no further adjustments are necessary thereafter.

Liquid Withdrawal System Idling

The idling of the engine is accomplished in two different ways. One is to bleed off a volume of fuel from the main fuel metering system in the carburetor and by means of an adjustment to control the air-fuel mixture ratio at a given throttle opening. The other arrangement requires an external idle fuel line connection between the carburetor and the secondary regulator of the vaporizer assembly. In this case, the idle fuel comes from two sources: (1) through the main gas orifice in the carburetor and (2) from an idle metering arrangement built into the secondary regulator. This source of the supplemental idle fuel is independent of the main gas supply to the carburetor, and the two sources of idle fuel combine to make a very satisfactory idling system.

Since economy at part-throttle operating conditions is also very desirable, means of providing control of part-throttle air-fuel mixture ratios is provided by different types of economizer devices, most of which are vacuum operated. Basically their design includes a means of reducing the main gas orifice area a predetermined amount from that required for full-throttle operation. By using the correct rate of spring-back of the economizer diaphragm, the cut-in point of the economizer can be shifted to that part of the range desired. These devices have proved satisfactory and are in wide use where variable speed and variable load conditions are encountered.

Vapor Withdrawal System

With the vapor withdrawal system of carburetion, LPG vapor is taken from the fuel cylinder or tank. This system has achieved some measure of popularity in the southern states on farm tractors because it eliminated the need for a fuel vaporizer and made possible the use of 100-lb domestic cylinders of propane. The vapor is taken from the fuel cylinder and passed through a first-stage regulator which reduces the tank pressure to a substantially low-pressure range. At this reduced pressure, the vapor fuel is passed through a secondary regulator and from there a spud-in attachment into the gasoline carburetor and on into the engine.

This type of system has some serious disadvantages. It cannot be considered a satisfactory all-year-round method of metering the fuel, due to the variations that will take place in the tank pressure as a result of changes in ambient temperatures. A substantial change in tank pressure necessitates the readjustment of the spud-in so that a proper mixture ratio can be maintained. Obviously, if the spud-in adjustment is made with a low tank pressure derived from a low ambient temperature, the mixture ratio will go rich when the ambient temperature rises 20 or 30 F and give substantial increase in tank pressure.

The other serious disadvantage to this method is the fact that the 100-lb cylinder does not have sufficient heat transfer area to be a good heat exchanger under continuous heavy fuel demand. Table 1 indicates the maximum continuous vapor draw in pounds that can be obtained from a 100-lb cylinder at various temperature levels.

The maximum volume or weight of vapor obtainable at a temperature of 70 F is only 14 lb with 100 lb of fuel, or a full cylinder. This 14 lb of propane is only 3.3 gal, and while it may be sufficient to handle certain farm tractor loads for a while, it is not sufficient to handle all operating conditions. It should be noted that as the volume in the cylinder decreases, the maximum continuous draw in vapor also decreases. For example, with only 50 lb of propane in the cylinder, a continuous draw of 7.8 lb of fuel can be imposed, whereas with only 10 lb of fuel remaining in the cylinder only 3.1 lb of fuel can be taken.

Since the fuel demand by the average size tractor engine is such as to be a great deal more than the cylinder's ability to recover and maintain the fuel within it at its original temperature, the temperature of the fuel within the cylinder also decreases—in other words, as it is commonly called in the field, refrigeration sets in.

This refrigeration process is manifested by a drop in tank pressure and the accumulation of frost on the exterior of the cylinder. As long as the fuel demand on the cylinder continues, the refrigeration cycle will continue and eventually the temperature of the fuel will be pulled down to the point where tank pressure no longer exists. As a result, while this process is going on, there is a leaning out of the fuel-air mixture ratio to the engine. Of course, finally the engine stops running altogether.

Reports coming in on field conversions of this type made during the past two years, indicate that valve-burning troubles are being experienced as a result of the leaning out of the air-fuel mixture ratio. We also find that some provisions are now appearing for providing heat to the 100-lb cylinder from the cooling system of the engine.

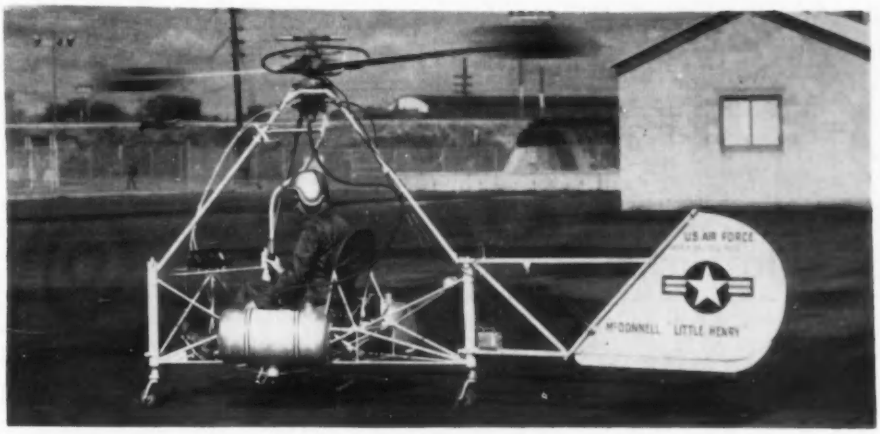
One of the original claims made for this type of system was its lower cost. However, the addition of some means to provide heat to the propane in the 100-lb container must of necessity run the cost up.

(Paper on which this abridgement is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, and 50¢ to nonmembers.)

Table 1—Vaporization of Propane from a Steel Cylinder of 100-lb Capacity

Propane in Cylinder lb	Heat Transfer Surface, sq ft	Maximum Continuous Draw at Various Temperatures, lb per hr — In Perfectly Dry Still Air			In Moist Air Having A Dew Point of 32 F	
		−20F	+30F	+70F	+40F	+70F
10	2.73	0.65	2.0	3.1	0.22	1.0
50	6.88	1.6	5.1	7.8	0.55	2.6
100	12.1	2.9	9.0	14.0	0.97	4.6

Little Henry



Proves Ramjet 'Copter Practical

BASED ON PAPER BY

Charles R. Wood, Jr.

Manager of Helicopter Contracts, McDonnell Aircraft Corp.

• Paper "Present Day Use of Helicopters" was presented at SAE St. Louis Section, Nov. 14, 1949.

"LITTLE HENRY" is powered solely by ramjets at its rotor tips.

This simple little experimental helicopter was built to determine whether or not ramjet propulsion is practical for helicopters. The answer is "yes," McDonnell Aircraft Corp. has found.

In contrast with conventionally powered designs, helicopters powered by ramjets at their rotor tips have these advantages:

1. No reaction torque is transmitted to the fuselage. Therefore no torque compensation device, such as a tail rotor, is needed.
2. Thrust is generated at the rotor, where it is used. No transmission, gearbox, clutch, or free-wheeling unit is required.
3. Useful load is greater because of the weight savings.
4. First cost is low.
5. No time is spent on engine warm-up.

Little Henry—the XH-20 to the Air Force—weighs 280 lb empty and normally flies at a gross weight of 625 lb. Its tiny ramjets perform equally well on 100, 91, or 80 octane aviation gasoline or regular grade. Flight at 50 mph takes only partial jet thrust.

Flight tests have been under way for some time. They prove that the ramjet helicopter is fully controllable about all axes, in climb or descent—in forward, sideward, and rearward flight. Spot turns in either direction, cartwheels, and lazy eights are easy for the pilot. In fact. the ramjet helicopter seems to be the simplest of all aircraft to fly.

Major development aim is reduction in fuel consumption. Maintenance is already very simple, regular cleaning of the liquid-injection fuel nozzles being one of the few requirements.

McDonnell's plans for a jet helicopter began back in 1943. Both ramjets and pulsejets were investigated. (Both accomplish compression without mechanical compressors. Ramjets are continuous-combustion units. Pulsejets admit and burn the charge intermittently.)

Ramjets suffer losses due to pressure drops in the combustion chamber and heat losses due to incomplete combustion of the fuel. Pulsejets suffer pressure losses through their intake valve mechanism and heat losses through dilution of the charge and variation in timing. Calculations showed that ramjet losses would be smaller than pulsejets losses. Besides, ramjets have no moving parts, make less noise, and require no lubrication.

McDonnell began developing a ramjet helicopter in 1944. Since 1946, the development and test program has been supported by the Rotary Wing Branch, Propeller Laboratory, Air Materiel Command. Little Henry flew its first official Air Force passenger in January, 1949.

Continuing tests have indicated that a service-type ramjet helicopter would have the endurance required for such military operations as observation, communications, wire-laying, spotting for artillery, photography, light cargo transport, carrier service, and rescue work. These operations could be performed in all weather, in all climates.

McDonnell engineers foresee use of ramjet helicopters for such civilian services as pest control on farms and even as an aerial motorcycle. Ramjet helicopters, they believe, can be easier to fly, cheaper to maintain, and—with quantity production—cheaper to buy than other types of rotary-wing aircraft.

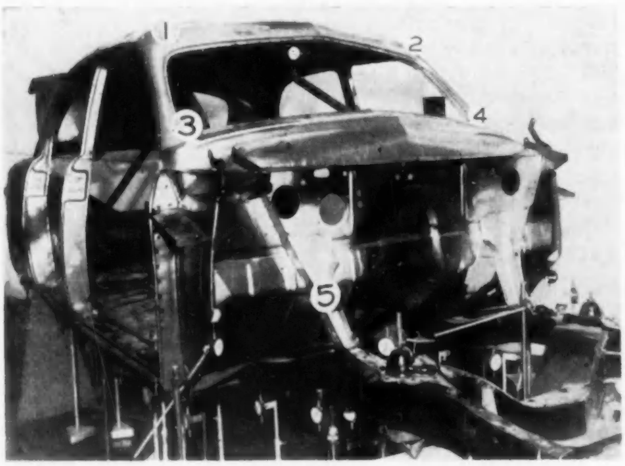
(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Auto Body-Frame Loads

BASED ON PAPER BY

Harold Hicks, Ford Motor Co.

• Paper, "The Nature of the Loads in Body and Frame Structures," was presented at Detroit Section meeting on Feb. 5, 1951. (Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)



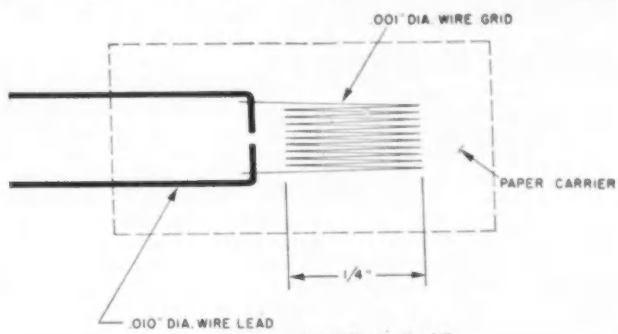
Automobile body-frame structures are subject to two common types of loading—twisting and bending. Determining the nature, location and value of stresses set up by these external load conditions is an important part of the body designer's job. This is done in a laboratory where body-frame structures are subjected to loading tests such as the right-twist test shown above. Here the structure is supported at the two rear and the left-front wheel centers, and a load of approximately 950 lb is hung at the unsupported right-front wheel center.

Before applying the twist load, parts to be investigated are coated with a brittle lacquer, called "Stresscoat." This special lacquer cracks at right angles to the direction of force in the member. And resulting stress patterns give an indication of the nature and degree of internal stress in the part. After twist-loading the body-frame structure, the lacquer is chilled with cold air to force the Stresscoat pattern. This illustration shows that the upper part of the right windshield pillar, (1) is under tension and bending with a right-twist load.

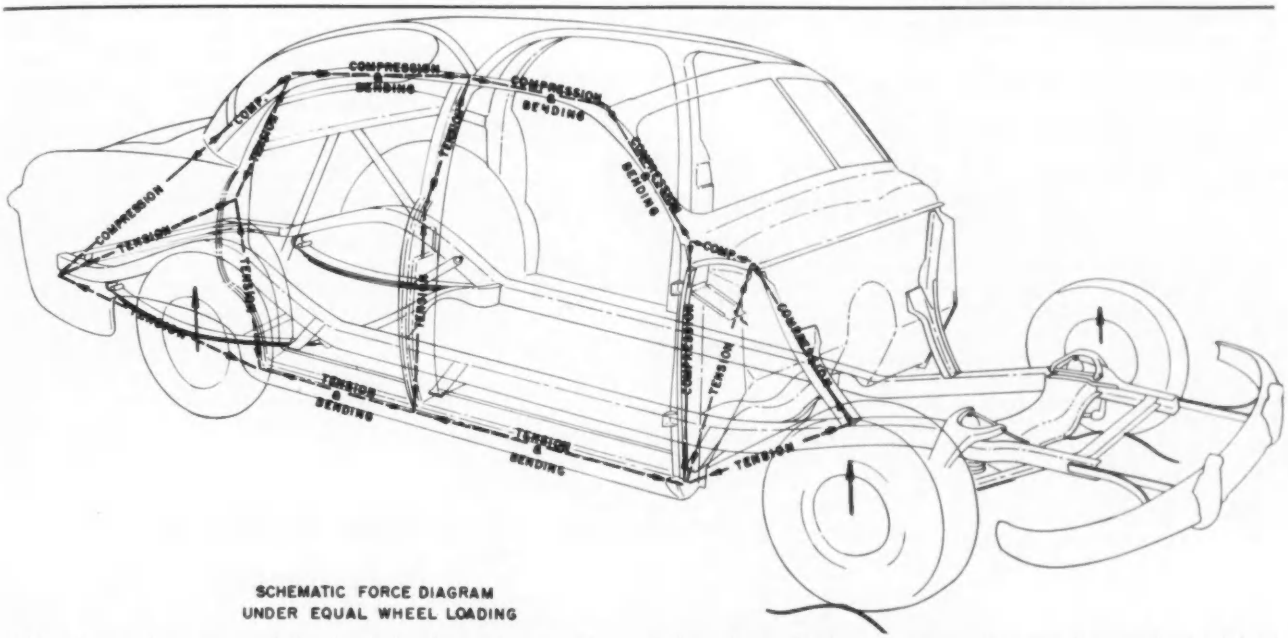
With the load hanging at the right wheel center, the angle at (1) and (4) tends to open, and the angle at (2) and (3) tends to close. The lower left part of the windshield pillar, (4) is under compression and bending.

The Stresscoat pattern for the back of the channel-type body bracket, station (5), shows that much of the tensile load in the strut is taken up by the dash through the lower welds.

This brittle lacquer coating method gives the designer general knowledge of the character of the strains in members. But another method is used to gain more precise knowledge of the stresses in these parts. A small strain gage has been developed which measures the intensity of these strains very accurately. Operation of this gage is based upon the simple principle of electricity that electrical resistance changes with length of wire. The fine wire grid, paper-mounted and cemented to the member to be investigated, stretches or compresses as the member is stretched or compressed. By measuring the difference in resistance—between unloaded and loaded conditions—to an electric current passed through the grid, the stress is determined.

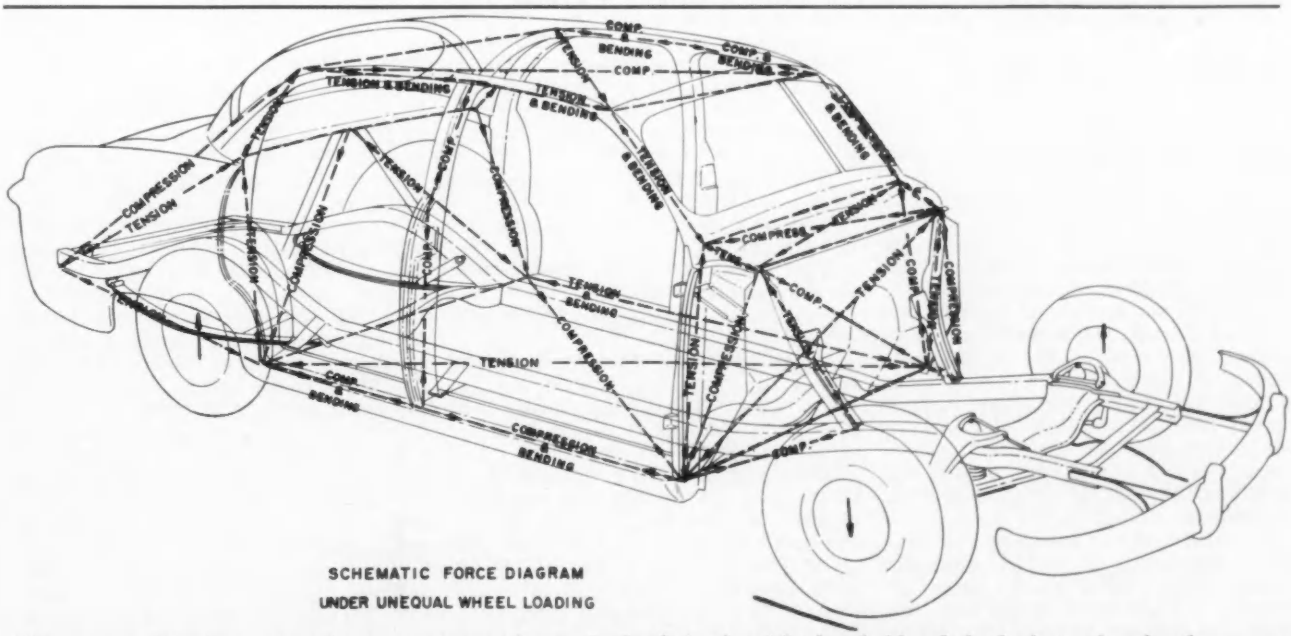


SR-4 STRAIN GAGE



SCHEMATIC FORCE DIAGRAM
UNDER EQUAL WHEEL LOADING

This shows the nature of the loads in the various sections of the primary load carrying structure under equal wheel loading. Greatest loads occur at the door openings where there is little definite structure.



SCHEMATIC FORCE DIAGRAM
UNDER UNEQUAL WHEEL LOADING

With unequal loads on the wheels, as shown above, the loads in the right hand side of the body tend to be the reverse of those in the preceding illustration.

Electronic Testing Quickens Maintenance

Based on paper by

REX J. L. DUTTERER

Hastings Manufacturing Co.

ELECTRONIC ignition test devices will locate the faults in any type of ignition system. The equipment requires only two simple connections to the ignition system for checking without disassembly and under actual running conditions. It locates the particular fault and points out where it occurs, thus making servicing quicker and more effective. It can be used as an engine test instrument or ignition development tool since it portrays the characteristics of the system so that it can be studied easily.

These electronic devices are sensitive. They have been used with 250 feet of cable between the instrument and the engine, thus making possible a centralization of equipment. Faulty parts or malfunctioning are located definitely, thus saving innumerable hours of time. Equipment permits service work to be checked in a few minutes to ascertain if repair is correct. Thus it permits the practice of real preventive maintenance. (Paper "Automotive Electronic Test Equipment" was presented at SAE Mid-Michigan Section, May 15, 1951.

Better Equipment Is Contractors' Need

Based on paper by

M. C. HARRISON

Harrison Construction Co.

IN 1942 we began to standardize on shovels that could work efficiently as a shovel, dragline, crane, or backhoe. One shovel worked all of these in one particular week. The speed of interchange was a big factor in the efficiency of the equipment.

Construction of equipment should always stress design that will minimize the loss of operating time due to inclement weather and design to get the maximum amount of production with a minimum of payroll.

Some attempt has been made to construct equipment to satisfy sectional requirements, but it hasn't gone far enough. At the start of the last war there was a trend to build equipment that would offset the increase in hourly wages. The government stopped it with an order designed to conserve steel, stating that no scraper could be built over 12 cu yd capacity struck level. I am surprised that no concerted howl went up, because we can prove that a scraper twice the size will move half again as much dirt with the same amount of steel and the same amount of payroll, thereby saving steel. (Paper "Machines and Methods" was presented at SAE Central Illinois Section, Earthmoving Industry Conference, Peoria, Ill., April 10, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

How Indianapolis Race Served Family Car

Based on paper by

DR. GEORGE A. BOWIE

Firestone Tire & Rubber Co.

APPROXIMATELY 70% of all mechanical improvements that have been incorporated into passenger cars originated, or at least were proved, at the Indianapolis Speedway, according to E. V. Rickenbacker, president of the track for 18 years. Some of the outstanding improvements are:

Tight sealing of oil in the engine and the development of better lubricating oils.

Greater durability of piston rings and spark plugs.

Practical elimination of steering mechanism failure through introduction of magnafluxing. Gradual decrease of steering ratio from 26 to 1 to a ratio nearer that of the race car 9 to 1.

Rear-view mirror. First appeared in the 1911 race.

Hydraulic shock absorbers replacing the friction type.

Four-wheel hydraulic brakes with single pedal control.

Balloon tires. First used in the 1925 race.

Tetraethyl-lead. First tried in 1923 race.

Now that fuel injection systems have been tried out and found to function satisfactorily at the Speedway, their adoption by passenger car manufacturers may be confidently expected. (Paper "Engineering Aspects of Indianapolis Race Cars" was presented at SAE Mid-Michigan Section, Flint, Mich., March 5, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Demands Design Changes As Safety Measure

Based on paper by

FREDERICK N. CLARKE

Commissioner of Motor Vehicles, State of New Hampshire

WE have volumes of laws and regulations designed for the protection of all users of our highways, but laws, no matter how uniform, are not the whole answer to our problem of prevention and control of traffic accidents.

We need a change in weight distribution and in space vision. Why should the front corner posts remain so large as to cut off much vision of the highway? We need a change in bumper strength, and in the instrument panel. Maybe the time has arrived and long since passed when a safety rail should be provided along the side of cars. This, certainly, would not upset the outside finish and it would give some protection. (After-coffee talk was presented at SAE New England Section, Jan. 2, 1951.)

Nylon is Superior In Earthmover Tires

Based on paper by

C. W. MOSS

The Goodyear Tire & Rubber Co.

EARTHMOVER tires have been made with cotton, rayon, and nylon fabric. The tensile strength of the basic fibers runs as follows: cotton 1¾ grams per denier, high tenacity rayon, as used in tires, 3¼ to 3¾ grams per denier, and nylon a minimum strength of 6¾ grams per denier. Rayon fabric has several advantages over cotton. Rayon has a higher flex fatigue resistance and in cases where heat does become a factor the superiority over cotton becomes even greater because there is much less loss of strength and fatigue resistance under heat. With rayon it has been possible to build a stronger tire with a cord much thinner than cotton and thus obtain a stronger but thinner carcass, which is a tremendous advantage in the prevention of heat build-up. Rayon is now the standard ply material for earthmover tires.

Nylon has heat resistance and flex fatigue resistance equal to or greater than rayon. It has another extremely valuable property in that it does not deteriorate on contact with water. This is highly important in earthmover

tires where cuts into the cord fabric and wet operating conditions give an opportunity for other cords to be damaged in service. These characteristics, together with extremely high tensile strength and resistance to damage from impact breaks, allow the building of a thinner yet stronger carcass than is possible with rayon. These qualities become even more important as earthmover equipment becomes larger and is designed to carry heavier loads. When the tires to go on this equipment begin to have such a large number of plies, the actual carcass thickness itself introduces problems of stress distribution both in its construction and in its use. Therefore, a change to a stronger yet thinner cord is of great advantage.

The use of nylon in earthmover tires will represent as big a step forward as was the change from cotton to rayon. At the present time, however, the amount of nylon available for tires is limited and it is improbable that this material can become the standard for some time to come. (Paper, "Design and Construction of Earthmover Tires" was presented at SAE Central Illinois Section, Earthmoving Industry Conference, Peoria, Ill., April 10, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

How to Travel 160 MPH Over Water

Based on paper by

STANLEY S. SAYRES

TED O. JONES

Boeing Airplane Co.

ANCHOR JENSEN

Jensen Motorboat Co.

D. B. SPENCER

Western Gear Works

THE Allison-powered SLO-MO-SHUN IV, holder of the World's Straightaway Record (160.3235 mph), idles at 45 mph and accelerates from that speed to 125 mph in 26 seconds. It reaches 160 mph after a run of approximately one mile. It has never yet been held wide open.

There are several reasons why the SLO-MO is faster than other unlimited boats of comparable design. Her sponsons are longer than the others and her engine and other weighty parts are placed farther forward which puts the center of gravity approximately amidship. This weight distribution is partly responsible for the stern riding clear of the water which reduces the wetted area.

Another factor which contributes to the free riding after-plane is the Hi Johnson 2-blade, 14 × 25 propeller, which is available in either positive, negative, or neutral lift. If the stern is a little heavy to raise, you install a positive blade. If the stern is too light, the negative is used, and if the balance is close the boat will become a proprider with a neutral blade. Regardless of the opinion of some experts, we can prove this to be true.

Each piece of hardware that must go through the water, such as rudder, fins, and water scoop, is reduced to a minimum in thickness. The reason, of course, is the resistance water offers to the most minute obstacle it encounters at high speed. And, finally, the boat is 1/3 lighter in weight than her competitors.

This joint paper also covers specifications, details of hull design, construction and outfitting, and step up gear drive. (Paper "The SLO-MO-SHUN IV" was presented at SAE Northwest Section, Seattle, Feb. 21, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

CALENDAR

NATIONAL MEETINGS

MEETING	DATE	HOTEL
	1951	
TRACTOR and PRODUCTION FORUM	Sept. 10-13	Schroeder, Milwaukee
AERONAUTIC, AIRCRAFT PRODUCTION FORUM, and AIRCRAFT ENGINEERING DISPLAY	Oct. 3-6	Biltmore, Los Angeles
TRANSPORTATION	Oct. 29-31	Knickerbocker, Chicago
DIESEL ENGINE	Oct. 29-30	Drake, Chicago
FUELS and LUBRICANTS	Oct. 31-Nov. 1	Drake, Chicago
	1952	
ANNUAL	Jan. 14-18	Book-Cadillac, Detroit
PASSENGER CAR, BODY, and MATERIALS	March 4-6	Book-Cadillac, Detroit
AERONAUTIC, AIRCRAFT ENGINEERING DISPLAY, and TECHNICAL AIR REVIEW	April 21-24	Statler, New York City
SUMMER	June 1-6	Ambassador and Ritz-Carlton, Atlantic City, N. J.
WEST COAST	Aug. 11-13	Fairmont, San Francisco
TRACTOR	Sept. 9-11	Schroeder, Milwaukee

1951 SAE Tractor Meeting and Production Forum

Sept. 10-13, Hotel Schroeder, Milwaukee

General Chairman

S. C. Heth
General Chairman
of Meeting

M. L. Frey
Chairman of
Production Forum

Monday, Sept. 10

9:00 a.m. Fifth Floor Foyer

PRODUCTION FORUM

Sponsored by SAE Production Activity

M. L. Frey, Chairman

10:00 a.m. to 12:00 noon—2:00 p.m. to 4:00 p.m.

Seven separate informal gatherings to exchange information and experience on vital production problems. Each will be sparked by a panel of experts as shown

Gears

Panel Leader:
B. W. KEESE, Wisconsin Axle Division, Timken-Detroit Axle Co.

Panel Members:
A. S. BLACK, Fellows Gear Shaper Co.
FRED BOHLE, Illinois Tool Works
F. H. BOOR, Wisconsin Axle Division, Timken-Detroit Axle Co.
IGOR KAMLUKIN, Allis-Chalmers Mfg. Co.
F. E. McMULLEN, Gleason Works
N. T. NILSON, International Harvester Co.
CHARLES STAUB, Michigan Tool Co.

Secretary:
DONALD RIEFF, Harnischfeger Corp.

Materials Handling

Panel Leader:
WILLIAM NAUMANN, Caterpillar Tractor Co.

Panel Members:
F. M. BLUM, Harnischfeger Corp.
EMMITT JOHNSON, International Harvester Co.
B. I. ULINSKI, Automatic Transportation Co.
J. L. VARGA, Ladish Co.
J. C. WEBB, Jervis B. Webb Co.

Secretary:
WALTER MAURER, Harnischfeger Corp.

Quality Control

Panel Leader:
H. A. WEISSBRODT, International Harvester Co.

Panel Members:
J. N. BERRETTONI, Dr. J. N. Berrettoni and Associates
E. L. FAY, Deere and Co.
E. R. MEYER, Caterpillar Tractor Co.
CARL SLATHAR, Minneapolis-Moline Co.
W. H. SMITH, Ford Motor Co.

Secretary:
JOHN SANTI, Marquette University

Welding

Panel Leader:
J. J. CHYLE, A. O. Smith Corp.

Panel Members:
J. D. BROWN, Allis-Chalmers Mfg. Co.
E. J. BRUGGE, Lincoln Electric Co.
C. H. BURGSTON, Deere and Co.
C. D. EVANS, International Harvester Co.
KENNETH JACKSON, Caterpillar Tractor Co.
E. MORRIS, Linde Air Products Co.

Secretary:
FRANCIS BRICKLE, Harnischfeger Corp.

Heat Treating

Panel Leader:
J. T. SCHOEN, Marquette University

Panel Members:
E. E. ALEXANDER, Caterpillar Tractor Co.
J. H. CLARK, International Harvester Co.
WALTER HOLCROFT, Holcroft and Co.
L. W. STEEGE, Deere and Co.
L. E. WEBB, Clark Equipment Co.
C. I. WESLEY, Wesley Heat Treating Co.

Secretary:
AL MAYER, Marquette University

Forging

Panel Leader:
J. J. DIERBECK, International Harvester Co.

Panel Members:
GEORGE DASCHKE, Packard Motor Car Co.
E. O. DIXON, Ladish Co.
R. L. MATTSON, General Motors Corp.
C. E. STONE, Interstate Drop Forge Co.
H. F. WOOD, Wyman-Gordon Co.

Secretary:
TOM GIALDINI, Ladish Co.

Foundry

Panel Leader:
F. J. WALLS, International Nickel Co., Inc.

Panel Members:
HYMAN BORNSTEIN, Deere and Co.
J. F. KLEMENT, Ampco Metals, Inc.
G. P. PHILLIPS, International Harvester Co.
HAROLD RUF, Grede Foundries
D. C. ZUGE, Sivyer Steel Casting Co.

Secretary:
DAVID PRALL, Marquette University

Tuesday, Sept. 11

9:30 a.m. Ballroom

Welcome to Milwaukee

C. H. Duquemin

Chairman, SAE Milwaukee Section

J. G. Storatz, Chairman

Bulldozer Power and Dimensions
—J. W. MARTIN and D. B. FOLGER, Bucyrus-Erie Co.

Modification of Standard Earthmoving Equipment for Military Requirements
—J. A. CALDWELL, Engineer Research and Development Laboratories, Fort Belvoir
(Sponsored by Construction and Industrial Machinery Subcommittee)

1:30 a.m Ballroom

J. E. Jass, Chairman

Performance Characteristics of All-Wheel Drive Motor Graders
—E. C. BROWN, Austin Western Co.

Characteristics of Tandem Drive Motor Graders
—H. W. STOELTING, J. D. Adams Mfg. Co.

he Goodyear Dynamometer Truck
—W. C. JOHNSON, Goodyear Tire and Rubber Co.
(Sponsored by Construction and Industrial Machinery Subcommittee)

Wednesday, Sept. 12

9:30 a.m. Ballroom

F. M. Potgieter, Chairman

Latest Development in Universal Propelling Unit
—MARTIN RONNING, Minneapolis-Moline Co.

Torque-Measuring Apparatus and Technique
—W. E. GUSTIN, John Deere Waterloo Tractor Works
(Sponsored by Implement Subcommittee)

1:30 p.m. Ballroom

H. B. Knowlton, Chairman

Current Practice in Tractor Bevel Gears
—W. H. WORTHINGTON, John Deere Waterloo Tractor Works

Factors Affecting Tractor Valve Performance
—K. L. PFUNDSTEIN and J. D. BAILIE, Ethyl Corp.
(Sponsored by Tractor and Farm Machinery Activity)

Thursday, Sept. 13

9:30 a.m. Ballroom

C. L. Zink, Chairman

Effects of Rim Width on Tractor Tire Performance
—E. G. McKIBBEN and I. F. REED, U. S. Department of Agriculture

Tractor Ride Research
—A. K. SIMONS, Bostrom Mfg. Co.
(Sponsored by Tractor and Farm Machinery Activity)

1:30 p.m. Ballroom

R. K. McConkey, Chairman

Draft Studies of "Side-Hitched Implements"
—A. J. WOJTA, L. O. ROTH, and F. W. DUFFEE, University of Wisconsin

Foreign Tractors and Implements
—R. B. GRAY, U. S. Department of Agriculture
(Sponsored by Implement Subcommittee)

7:00 p.m. Ballroom

DINNER

R. C. WILLIAMS
Chairman

P. H. NOLAND
Toastmaster

DALE ROEDER
SAE President

"Free World at the Crossroads"
J. S. DUNCAN
President and Chairman
Massey-Harris Co., Ltd.

25 Years Ago

Facts and Opinions from SAE Journal of August, 1926

Edward P. Warner, currently a member of the SAE Council, has been named to the newly created position of Assistant Secretary of the Navy for Aviation.

■

It has been decided to organize a Production Committee of the Society. . . . It will develop activities of interest to production members with relation to standardization, research, presentation of papers, and the holding of meetings both Section and National.

■

SAE has accepted joint sponsorship with the ASME for a Sectional Committee on Small Tools and Machine Tool Elements under the procedure of the American Engineering Standards Committee.

■

About 85% of cars equipped with approved locking devices are habitually left unlocked when parked. Education of the public to use locking devices has been too slow. It is almost imperative that some more direct means be found to combat theft losses.

The coincidental lock came into being specifically to meet this situation. Drivers almost universally turn off the ignition switch when leaving a car unattended, and that is about the only operation all drivers can be depended upon to perform. . . . The coincidental lock seeks by one means or another to take advantage of this fact by making the locking and the ignition functions interrelated so that it is impossible to open the ignition circuit switch without either previously or simultaneously locking the car.—From paper on "Coincidental Locks" by Charles M. Manly and C. B. Veal, consulting engineers.

SAE has named a representative to an AESC Sectional Committee to formulate national standards for drawings and drafting room practice. Scope of the Committee's project is:

"The classification of and corresponding nomenclature for drawings in accordance with their purpose; method of representation of the subject, including arrangement of views and sections; use of lines of different kinds of thicknesses; indication of dimensions, tolerances and fits, tapers and slopes, and surface or finish; symbols for elements; indication of materials by cross-hatching; arrangement of borderline, title, part list, notes, changes and revisions; method of folding and punching; kinds and sizes of lettering, figures and symbols; scales of reduction and enlargement; sizes of drawings and filing cabinets; width of rolls of paper and cloth; size of drafting equipment and tools, and specifications for materials to be used for drawing and drafting."

■

At the May meeting of the Iron & Steel Division, the desirability of including the Rockwell Hardness Test in the present SAE Recommended Practice for Hardness Tests was recognized.

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Talking of "Engine Requirements of Interurban Motorcoach Service," L. P. Kalb, assistant chief engineer, Continental Motors Corp., expressed to the Metropolitan Section the opinion that:

"For a sustained vehicle speed of 45 mph, with an engine speed not much above 1800 rpm, a gear ratio of 4¼ to 1 is best."

About

ROBERT E. WILSON, chairman of the board, Standard Oil Co. (Ind.), on June 21 delivered the Cadman Memorial Lecture before the Institute of Petroleum and was presented with the Cadman Memorial Medal. Dr. Wilson is the third recipient of this award, which was established in memory of Lord Cadman to honor outstanding contribution to the petroleum industry. The lecture, entitled "Competitive and Cooperative Research in the American Petroleum Industry," was delivered at the Royal Institution, London.

D. R. SHOULTS, formerly director of engineering for Aro, Inc., of St. Louis, has been appointed director of General Electric Company's aircraft nuclear propulsion project for the Air Force and Atomic Energy Commission. The project, which is engaged in further development of an atom-powered engine for airplanes, will have headquarters at Lockland, Ohio.

NELSON R. BROWNYER, vice-president of Timken-Detroit Axle Co., will supervise the organization of the new field sales and service engineering department of Timken-Detroit, President **WALTER F. ROCKWELL** has announced. The new group has been established to bring about a better knowledge of actual field requirements and performance of Timken-Detroit products, resulting in closer coordination between production, engineering and sales.

ARTHUR J. WILLIAMSON has been appointed vice-president in charge of manufacturing operations by Tube Reducing Corp., Wallington, N. J. For thirteen years prior to this appointment he was with Summerville Tubing Co., for five years as plant manager at Carnegie, Pa., and as chief metallurgist at Bridgeport, Pa.

ELBERT FOWLER, formerly associated with Pitney-Bowes, Inc., is now consulting engineer to Bendix Westinghouse Automotive Air Brake Co., Elyria, Ohio.

JOHN F. CREAMER, treasurer and chairman of the board of Wheels, Inc., has been elected president of the Metropolitan Council of the Automobile Old Timers.

J. HOWARD PILE, previously general manager of "Fleet Owner" and more recently engineering and sales promotional consultant, has joined the Office of Price Stabilization in Washington as chief of the Automotive and Mechanical Section, Service Trades Branch, in Tempo E Building. His consulting work will be continued. Pile was for many years vice-president and editorial director of the Chek-Chart Corp., Chicago.

RAYMOND W. YOUNG, who last October joined Reaction Motors, Inc., as vice-president in charge of engineering, is now Reaction's president and general manager. Young was SAE vice-president representing aircraft engine engineering activity in 1945.

DONALD A. ELLIS has been elected vice-president and general manager of Shop of Siebert, Inc., of Toledo. Ellis was associated with Willys-Overland Motors, Inc., for five years, and was manager of fleet and truck sales department during the past year.

EDMUND C. SULZMAN, formerly sales manager for Wright Aeronautical Corp., has been appointed vice-president of Jack & Heintz Precision Industries, Inc., of Cleveland.

CHARLES A. CHAYNE has been elected chairman of the Engineering Advisory Committee of the Automobile Manufacturers Association, succeeding **JAMES M. CRAWFORD** who retired recently. Chayne is vice-president of engineering of General Motors Corp.

HELMER PETTERSON of Gothenburg, Sweden, has been spending several weeks in this country displaying his cam engine to U. S. automotive manufacturers in Detroit and other mid-west cities. Petterson is president of his own company in Gothenburg.

VERNE H. SCHNEE, vice-president of the University of Oklahoma, is currently on leave from the university and working with the National Research Council as executive director of the Metallurgical Advisory Board. **WALTER E. JOMINY** of Chrysler Corp. has been appointed chairman of the Boron Group of the board. Prime function of the board is to offer technical advice to the military services.

FRED T. ROBERTS has been promoted to manager of truck, bus and trailer wheel sales, Budd Co., Detroit. He will continue to be in charge of all wheel service and distributor wheel sales.

ALBERT E. BROWN is now field service engineer with Buda Co., Harvey, Ill. He was formerly with American Bosch Corp.

Members

WALTER B. KING, JR., assistant professor at the University of Miami, has been ordered to active duty with the Army. He is serving with the 841st engineering aviation battalion at Fort Huachuca, Ariz.

JAMES K. FULKS, since 1942 vice-president in charge of manufacturing, Ex-Cell-O Corp., Detroit, has been appointed executive vice-president of that firm, a newly created post.

J. F. WOLFRAM, vice-president of General Motors Corp. and general manager of GMC Oldsmobile Division, has announced the production of 3.5-in. rockets for the Army's super bazooka by Oldsmobile. The company is also preparing to manufacture high velocity tank guns and turbine and compressor units for the Wright J-65 Sapphire jet aircraft engine.

ALLEN TAYLOR, who retired from the Shell Oil Co., Inc., in January, is now with the Bureau of Aeronautics, Department of the Navy, in Washington. He is working on aviation refuelers.

GERALD A. PETERSON, formerly senior cost analyst at Ford Motor Co., has been promoted to supervisor of engineering change cost analysis section.

LEWIS K. MARSHALL has been appointed manager of the Lincoln-Mercury Division Gas Turbine Plant, **BENSON FORD**, vice-president of Ford Motor Co. and general manager of the Lincoln-Mercury Division, announced. Marshall will have charge of the production of Westinghouse J-40 Jet Engines for the U. S. Navy, which will be produced in a new plan at a location not yet selected. During World War II, Marshall served with the Navy Department's Bureau of Aeronautics, and is currently a member of the Naval Reserve Air Advisory Council. Since last June he has been field relations representative for Lincoln-Mercury.

HARLAN RAY GREENMAN, formerly with GMC's Pontiac Motor Division, Pontiac, Mich., is now with Associated Designers, Birmingham, Mich.

BERTHOUD C. BOULTON, who has chief engineer at the Des Moines works of John Deere Co., is now associated with New Idea Corp., Coldwater, Ohio, as production design engineer.

PYKE JOHNSON, president of the Automotive Safety Foundation, Washington, D. C., and **NORMAN DAMON**, vice-president of the foundation, were honored at a dinner given June 10 by the Traffic Institute of Northwestern University in Evanston, Ill., and presented with diamond-studded keys in recognition of their service to the institute. The Traffic Institute, which offers special training in the field of accident prevention and traffic supervision, was founded 15 years ago with funds provided by the Automotive Safety Foundation, and has received constant support from the foundation.

ARTHUR NUTT, formerly of Arthur Nutt & Associates, is now director of engineering and contracts for the Bridgeport-Lycoming Division of Avco Mfg. Corp. in Stratford, Conn.

JOHN L. HACKER is on military leave of absence from GMC Electro-Motive Division, La Grange, Ill., where he is a field contact engineer. Lieutenant Hacker is aboard the U.S.S. Manchester in Korean waters.

ROBERT B. POWELL is now a design engineer at the experimental and development laboratory of International Latex Corp., Dover, Delaware. Prior to this he was chief designer for Indian Motorcycle Co. of Springfield, Mass.

To Be ASME President

SAE Past President **R. J. S. PIGOTT** has been nominated as president of the American Society of Mechanical Engineers for 1952. Director of engineering of Gulf Research & Development Co., Pittsburgh, Pigott will be the first to have held the presidency of both SAE and ASME. . . . His career includes 11 years in design, construction and operation of central power stations; 7 years in designing and constructing power and industrial plants; and 18 years in petroleum engineering research. He was president of SAE in 1948.

B. B. NYE, who was sales engineer for Lear, Inc., at Grand Rapids, Mich., is now sales engineer for Lear and its Romec Division in Forth Worth, Texas.

McCloud

J. L. McCLOUD, manager of manufacturing research, Ford Motor Co., has been elected president of the Engineering Society of Detroit. McCloud, who was SAE vice-president representing engineering materials activity in 1948, has been with Ford since 1915 in various capacities dealing principally with chemical and metallurgical research and testing. He was elected to the board of ESD in 1949 and since then has held the offices of assistant treasurer and first vice-president. **EARL BARTHOLOMEW**, general manager of research laboratory, Ethyl Corp., was elected second vice-president of the Engineering Society, and **KENNETH R. HERMAN**, vice-president, director and general manager of Vickers, Inc., was elected assistant treasurer. Others serving on the board of the Engineering Society of Detroit for the coming year are **FRANK H. RIDDLE**, vice-president and factory manager, ceramic division, Champion Spark Plug Co.; **ALLEN C. STALEY**, Chrysler Corp. (retired); and **GRANT S. WILCOX, JR.**, staff assistant, Chrysler Corp.

THEODORE P. WRIGHT (right), acting president of Cornell University, accepts a United Nations flag for Cornell from Floyd Morter, Jr., an agriculture student.

About the time **THEODORE P. WRIGHT** was finishing his five-month tour of duty as acting president of Cornell, the **Cornell Daily Sun**, a student publication, had the following to say in a quite unusual tribute to the man who continues as Cornell's vice-president of research:

"At Cornell we have an amazing paradox. Theodore P. Wright, the very man who is in charge of organizing and expanding the University's research program is the same individual who, acting as Cornell's president for a five-month period, has established the warmest and most cordial relationship with the student body of any president we have known or can think of in recent years.

"Perhaps the conception of a college president as a friend of the student has become antiquated and romantic; there are so many pressing administrative problems in an institution this large that one might often be called childish in hoping for a president who has the time or inclination to keep a close liaison with his students.

"But even if it is antiquated, romantic, and childish, nevertheless that is the point of view we must take, for we feel that the past few months with Dr. Wright serving as Acting President have been months of gratifyingly close relations with the head of the University Administration.

"We cannot express fully enough the deep appreciation we hold for a man who will take time out from his usual duties to attend lecture after lecture as an inconspicuous member of the audience; for a man who can be seen, on a Saturday afternoon, sitting in the Hoy Field stands cheering a Cornell team on to victory; for a man who is willing to discuss openly the problems of the University with any and all members of the student body.

"Short though his tenure of office may have been, Dr. Wright is a leader whom we shall not soon forget. Here, indeed, is our conception of a university president."

NICHOLAS KENT, service representative of Caterpillar Tractor Co. in Jacksonville, Fla., has been promoted to service manager at the company's main office in Peoria, Ill.

WILLIAM F. SMITH, JR., who has been teaching at New Mexico College of A and M, has accepted a position with the Chance Vought Aircraft Division of United Aircraft Corp., Dallas, Texas.

RICHARD W. HOYT, chief engineer of Double Seal Ring Co., Fort Worth, Texas, has been appointed vice-president of the company. Hoyt is secretary of the SAE Texas Section.

KENNETH LEE HOLLISTER, formerly assistant to the manager, technical and research division of The Texas Co. in New York, has been promoted to Detroit representative of that division.

JAMES C. HUGHES, who was with Ethyl Corp.'s research laboratories in Ferndale, Mich., is now associated with Southwest Research Institute, San Antonio, Texas.

MICHAEL SCHINAGEL has joined the aviation gas turbine division of Westinghouse Electric Co., Philadelphia, Pa.; he was formerly at the New York Naval Shipyard Material Laboratory.

RICHARD E. VAN DOREN, formerly employed at the Thermoid Co. of Trenton, is now a brake test engineer for Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.; he has recently been conducting tests for Bendix at Jamestown, Pa.

RALPH R. MATTHEWS, retired executive vice-president of Battenfeld Grease and Oil Corp., is now executive secretary of Industrial Oil Compounders Association.

CAPT. BENNETT MORRIS HENDERSON, research engineer for Shell Oil Co. at Wood River, Ill., is now on military leave of absence to the Army. Captain Henderson is stationed at Travis Air Force Base, Calif.

V. H. F. HOPKINS, formerly with C.A.V. Ltd., London, is now chief engineer to Marshall Sons and Co., Ltd., of Gainsborough, and to John Fowler & Co., of Leeds.

HOWARD M. GAMMON, who was senior test engineer at Thompson Products, Inc., Cleveland, Ohio, has been promoted to assistant chief technologist for the company at Inglewood, Calif., where he will conduct laboratory research on aircraft fuel systems and components.

JEROME S. BUZZARD, formerly with the Fairchild Engine and Airplane Corp., Oak Ridge, Tenn., is now associated with International Harvester Co. in Fort Wayne, Ind.

JACK E. GIECK is now in the department of technical data and information of the Chrysler Corp., Detroit, Mich. He was formerly with the Firestone Industrial Products Co., also in Detroit.

GEORGE B. HILL, who used to be with the New Holland Machine Division of Sperry Corp., is now in the engineering department of the New Idea Division of Avco Mfg. Corp., Coldwater, Ohio.

ALFRED R. PUCCINELLI, JR., is now an aeronautical engineer, power-plant installations, for the Civil Aeronautics Administration at Idlewild Airport. He was formerly associated with Wright Aeronautical Corp.

FRANK ARTHUR DONALDSON, JR., formerly vice-president of Donaldson Co., Inc., is now president and general manager of that firm. Donaldson was chairman of the SAE Twin City Section for 1950-51.

RAYMOND P. LANSING will have overall supervision of the Utica plant which Bendix Aviation has just bought from Continental Can Co. and in which 2,000 men will be employed. A Bendix vice president, Lansing will also have supervision of five other Bendix plants. Bendix will use its new Utica plant to facilitate expanded production for the military services.

Fluid mechanics and thermodynamics, heretofore presented to engineers as two separate subjects, have now been combined in a single textbook by **NEWMAN A. HALL**, professor of mechanical engineering at the University of Minnesota. Entitled, "Thermodynamics of Fluid Flow," the new book puts major emphasis on theory, although practical applications are also considered.

Fluid flow problems are handled under two main assumptions: (1) that the flow is steady and (2) that the flow is one-dimensional.

Fundamental principles are stressed in the sections dealing with the thermodynamics of the flow of fluids other than perfect gases, such as liquids and imperfect gases.

Publisher is Prentice-Hall, New York.

ALBERT W. YATES is now field service representative of the Fairchild Engine Division of Fairchild Engine & Airplane Corp., Farmingdale, N. Y. Yates was previously associated with Pure Oil Co., Minneapolis, Minn. In his new post he will be in charge of all service functions relating to the auxiliary power plant manufactured by Fairchild for the Armed Services.

ERNEST W. FULLER, who was formerly assistant to the vice-president of American Airlines, Inc., at Flushing, N. Y., has been appointed director of staff engineering for that company.

EDERICK C. CRAWFORD, president of Thompson Products Inc., has en elected a member of the board of rectors of Eastman Kodak Co.

UGENE A. BRUHA, formerly a service representative with Studebaker orp., is now automotive fleet service ngineer with the Tennessee Valley Auhority at Chattanooga. He will be vorking on the design, construction nd maintenance of all types of equipment employed by the TVA in the building and servicing of dams, power ines, and roads.

HENRY C. McCASLIN has been named executive engineer of Willys-Overland, Inc., by **CLYDE R. PATON**, director of engineering. McCaslin has been with the company since 1949 as general purchasing agent. At the same time **PHILIP C. JOHNSON** was promoted from assistant chief engineer to assistant executive engineer.

ROBERT B. SCHENCK, chief metallurgical engineer of GMC Buick Motor Division, retired on July 1 after 36 years of service with the corporation.

Schenck was one of the nation's earliest exponents of the use of boron-treated steel, which uses fewer critical materials. His work in metallurgy resulted in his appointment as supervisor of research at Buick for the National Research Council during World War II. His research was instrumental in the development of the steel cartridge case which released copper for other uses, and he and his staff also developed new methods of making armor plate and armor-piercing shot. He was given an Army-Navy certificate of appreciation for his contribution to the war effort.

Robert B. Schenck

It was under his supervision as chief metallurgist that Buick adopted high manganese steels for axle shafts and steering gear parts.

In addition to being an active member of SAE since 1922, Schenck is a member of American Society of Metals, Engineering Society of Detroit, the British Iron and Steel Institute, and other trade and scientific societies, and an active participant in the civic and community affairs of Flint, Mich., where he has lived since 1934.

Born in Beacon, N. Y., Schenck attended high school in Brooklyn and then Lehigh University, where he took his degree electrometallurgy.

ALEXANDER LENGYEL is now design analytical engineer at Fairchild Engine Division of Fairchild Engine and Airplane Corp. Farmingdale, N. Y. For the past year he has been instructor of mechanical engineering at New York University College of Engineering. Lengyel received his master's degree from the university in 1950, and is now a candidate for a doctorate.

DONALD J. WAHLER, general manager of United Buff Products Corp., Passaic, N. J., has announced the completion of a new manufacturing plant in Passaic. The new plant, which will turn out Airflow buffs and Aircon contact wheels, is designed for straight line production, starting with raw materials at one end of the building and ending with shipment of the finished products at the other.

W. DEAN BURTON, formerly with Consolidated-Western Steel Corp., Los Angeles, is now with Sverdrup & Parcel, Inc., consulting engineers, St. Louis, Mo.

HAROLD S. VANCE, president of Studebaker Corp., has announced that Studebaker will be in production next year on General Electric turbojet engines for use in the Boeing B-47 stratojet. Parts of Studebaker's South Bend plant, its new plant in New Brunswick, N. J., and a plant which the government has made available in Chicago will be used in building the aircraft powerplant.

J. H. CARMICHAEL, president of Capital Airlines, Inc., and **T. M. MATSON**, director of Bureau of Highway Traffic, Yale University, have been elected to the transportation and communications committee of the Chamber of Commerce of the United States.

B. H. DeLONG has retired as vice-president and technical director of Carpenter Steel Co., Reading, Pa., after 41 years of continuous service with the company. DeLong will continue to serve as a member of the board of directors. At the same time **DR. CARL B. POST** was promoted to chief metallurgist with Carpenter.

LLOYD LOWERY, who was principal of the Honolulu Automotive School, is now plant superintendent with E. E. Black Co. in Honolulu, T. H.

ALEX TAUB, of Alex Taub Associates, has formed the new Taub Engineering Co. for carrying forward special defense work. Preliminary design work has been carried out in Washington, D. C., but during August the company will move to Miami, Fla., where a design machine shop and laboratory facilities are in preparation.

JOSEPH J. BROWN has been promoted to industrial sales manager for the Malaya-Thailand Division of Standard-Vacuum Oil Co. He was formerly technical sales engineer in the same division.

HARVEY S. FIRESTONE, JR., (right), chairman of Firestone Tire & Rubber Co., received the honorary degree of Doctor of Laws from President H. E. Simmons of the University of Akron at the university's 79th commencement. The citation presenting Firestone for the honor described him as "an outstanding industrialist and exemplary citizen, who has served his company, his community and his country with distinction. In the fields of social service, education and religion, he has provided sound leadership and contributed wise counsel."

HARRY F. BARR has returned to Detroit from Cadillac's Cleveland Tank Plant to become assistant chief engineer of Cadillac in Detroit. **SHELDON G. LITTLE**, who was head of testing and development section for Cadillac in Detroit, will go to the Cleveland plant as assistant chief engineer.

PHILIP CHASE has been appointed manager of outside production for Hydro-Aire, Inc., Burbank, Calif., **J. H. OVERHOLSER**, executive vice-president, has announced. Chase was formerly purchasing agent for Northrop Aircraft.

SAMUEL J. LEE, formerly president of Fleet Management Corp., Chicago, is now vice-president and general manager of Grand River Chevrolet Co. of Detroit. Lee is the author of the book "Automotive Transportation in Industry," published last Fall. He has been an active member of SAE Chicago Section.

GEORGE H. SCHWARZ is a construction engineer with the Army working with problems of layouts for various services. He is attached to Engineering Branch, EES Headquarters.

L. W. PICKENS has been promoted to staff engineer with Aeroquip Corp., Jackson, Mich. He was formerly sales engineer with Aero-Coupling Corp. of Burbank, Calif., a subsidiary of Aeroquip.

JIM LANDERS, formerly president and general manager of Skyline Kaiser-Frazer Co., has opened the Jim Landers Motor Co., a Dodge-Plymouth dealership, in McKinney, Texas.

OBITUARIES

Two Founder Members Pass

ARTHUR J. MOULTON

JOHN WILKINSON

Arthur J. Moulton, a founder and life member of SAE, died at his home in Newport, R. I., on July 7 after an illness of several months. Moulton was 68 years old.

Moulton was born in Elberon, N. Y., and educated at Princeton University. He continued independent scientific and inventive research after graduation, and together with the late Charles Lanier Lawrence and Robert Breese he helped develop and produce the B.L.M. automobile, one of the earliest American sports models.

He was an extensive traveler, interested especially in North Africa, and was a devotee of yachting and fishing. In recent years he passed much of his time in Europe. In France he acquired the Chateau de la Verriere, a 600-acre estate a short distance from Paris.

At the beginning of World War II Moulton converted the estate into a hospital and convalescent center, which was annexed to the American hospital at Neuilly. When the Germans occupied Paris, he was interned in the Fresne prison. He returned to the United States in 1948 and established a home at Newport, which he re-named La Verriere.

Since then he and Mrs. Moulton have divided their time between Newport and their home at Palm Beach.

Moulton was the 45th member of SAE, having joined in May, 1905. He was also a member of the Union Club, the New York Yacht Club, and many others. He is survived by his wife, his sister, two sons, a stepson, a niece, and a nephew.

John Wilkinson, a founder and life member of SAE, died June 25 at the age of 83. Aircooled engine designer and holder of innumerable patents, Wilkinson was an automotive pioneer whose inventive spirit and devotion to the improvement of the automobile stayed with him throughout his long life.

Wilkinson was born in Syracuse, N. Y. He attended Cornell University, where he studied mechanical engineering. He was a member of the first Cornell football team, the tennis team and baseball squad, and was a leading bicycle racer.

He entered industry as a machinist for E. C. Stearns & Co. of Syracuse, and then went to Brooklyn, N. Y., with Henry R. Worthington Pump Co. He returned to Syracuse to join Solvay Process Co. as a draftsman and four years later moved to Syracuse Cycle Co.

Wilkinson's experiments with automobiles led him to build a car incorporating an aircooled engine and an air compression self starter in 1899. The New York Automobile Co. was formed by a group of Wilkinson's friends, but disintegrated without having gotten into production. H. H. Franklin then saw and became interested in the car, which made 35 mph, and the H. H. Franklin Mfg. Co. was formed to develop Wilkinson's innovations. The company continued in operation for more than 30 years.

Under the technical direction of John Wilkinson, the Franklin Co. compiled an impressive list of innovations. In 1902 the company had used valve-in-head engine cylinder, throttle control, float-feed carburetor, and lightweight, flexible automobile construction. In 1905 it produced its first six-cylinder engine, and the following year employed drive through springs and transmission service brakes. Franklin Co. adopted automatic spark advance in 1907, and in 1912 employed individual recirculating pressure feed oiling systems for engines.

The company was an early user of exhaust jackets for heating intake gases and of aluminum pistons. Wilkinson retired from Franklin in 1926, having been chief engineer, vice president, and director.

John Wilkinson was one of three engineers chosen to test Liberty motors for the government in 1918, and in 1942 was cited for the part played by his aircooled motor in the war effort.

Wilkinson never lost his love of sports. He was an honorary member of Onondaga Golf and Country Club and one of its oldest members. But his main interest was always the improvement of automotive design. In boating on Skaneateles Lake, Wilkinson combined his professional and sporting interests, for his boats were powered with Franklin engines in which he had installed water-cooled cylinders.

One of John Wilkinson's great qualities as an engineer was the faculty of inspiring others with his own enthusiasm for finding new answers to problems. He maintained this enthusiasm to the last year of his life, and at the time of his death had completed drawings and a wooden model of a new rotary valve engine.

Wilkinson is survived by his wife, whom he married in 1896; a daughter; and seven grandsons, four granddaughters, and six great-grandchildren.

RONALD J. WATERBURY

Ronald J. Waterbury, assistant chief engineer of Chevrolet, died on July 9 in Henry Ford Hospital, Detroit, after an illness of two months.

A large part of his business career was with General Motors Corp. and he was active in SAE throughout the years of his membership which began in 1927.

He joined the engineering department of Oakland Motor Car Co. in 1919, after working briefly with the Michigan State Highway Department, with Packard, and with Studebaker. He studied engineering at Michigan State College before entering industry.

At Oakland, he became body engineer and then, in 1925, joined Central Manufacturing Co. in Connersville, Ind., as chief engineer.

Passenger car body and sheet metal

design became his charge at Chevrolet when he joined that organization in 1929. In 1941, he became staff engineer on both commercial and passenger car bodies—and, from February, 1949, was assistant chief engineer.

In SAE he played important roles in both technical and administrative operations. He served as SAE Vice-President for Passenger Car Body Engineering in 1936 and was long a member of the Passenger Car Body Activity Committee. In 1945-46, he was chairman of the Detroit Section of which he previously had been secretary. In 1947, he served as chairman of the National Sections Committee.

He was a member of the Army Ordnance Association, of the Pine Lake Country Club, and the Canada Creek Club.

He was born in Ionia County, Michigan, on Dec. 2, 1898 and had his early education at Clarkson High School and Ferris Institute. His home was in Birmingham, Mich.

JAMES J. SHANLEY

James J. Shanley, 64, died on June 26 in Elizabeth, N. J. Shanley was for 14 years chief inspector for the motor vehicle department of the State of New Jersey, in charge of equipment and driver licensing examinations.

After serving in France in World War I, Shanley joined the motor vehicle department in 1917. He was named chief of the inspection division in 1937 and in this capacity set up the system of state-operated inspection stations to which all vehicles registered in New Jersey must report twice yearly.

Shanley was a member of the engineering committee of President Truman's Highway Safety Committee, the ASA Sectional Committee on Safety Glass and SAE Lighting Committee; as chairman of the engineering committee of the American Association of Motor Vehicle Administrators, he was a leader in cooperative activities with the automobile industry leading to the development of standardized sealed beam headlights and flashing turn signals. Shanley was also a member of the Knights of Columbus and the American Legion.

LEON A. CHAMINADE

Leon A. Chaminade, assistant to the chief engineer of GMC Chevrolet Motor Division, died in Detroit on June 26 on the eve of his retirement.

Chaminade was 61. Born in Trenton, N. J., he worked at jobs ranging from private chauffeur to window trimmer before receiving his technical education at Pratt Institute. His first connection with the automobile industry was as a draftsman at Studebaker Corp. Later he had various engineering assignments with the company until 1934 when he became a project engineer for Chevrolet.

He was engineer in charge of chassis and assistant staff engineer in charge of design before being named staff engineer in 1945. Because of ill health he had been largely inactive for the last few months and planned to retire June 30.

In addition to being an active member of SAE for 32 years and chairman of the Detroit Section in 1940-41, Chaminade was a member of the Engineering Society of Detroit and American Engineering Society. He was also a member of the Detroit Yacht Club. He is survived by his wife, son, and two daughters.

CLARENCE C. CARLTON

Clarence C. Carlton, vice-president and secretary of Motor Wheel Corp., of Lansing, died June 9 at the age of 69. He had suffered from a heart ailment since 1946, and death followed a long illness.

Carlton began his industrial career after graduating from the University of Akron and serving as Superintendent of Schools in Mantua, Ohio, and Medina, Ohio. In 1912 he became secretary to Harvey Firestone, president of Firestone Tire and Rubber Co., and in 1917 joined the Prudden Wheel Co., of Lansing, as sales manager. When in 1920 Prudden merged with two other companies to form Motor Wheel Corp., Carlton was named secretary of the new company and held that position until his death. He was elected vice-president in 1938.

Active in government service, Carlton was chairman of the automotive parts committee of the Automotive Division of War Production Board and Office of Price Administration and managing director of the automotive committee for Air Defense in 1940. During World War II he served as director and vice-president of the Automotive Council for War Production. Following the war he was chairman of the Michigan Committee on Economic Development, which was created to stimulate post-war business activity and decrease unemployment.

Carlton was a director from Michigan of the National Manufacturers Association and the American Congress of Industry, and was active in local civic and masonic affairs. He led in the formation of the Lansing Safety Council and was its first president in 1939. He is survived by his wife, his stepson and two sons, and a granddaughter.

EDWIN B. JACKSON

Edwin B. Jackson died on April 15 at St. Simons Island, Ga., after an illness of a few days. He was 74.

Born in Woodstock, Ontario, Jackson was educated at the University of Toronto. He was a former president of Packard Motor Car Co. of New York, a sales agency; vice-president of Willys-Overland, Toledo; president of Locomobile Co. of America; and chairman of the board of Stutz Motors.

For the last 10 years Jackson was president of Lock Thread Corp., of Detroit. He was a member of the Detroit Athletic Club, where he resided, and of the Racquet Club of Philadelphia. At the time of his death Jackson was vacationing in Georgia.

STANLEY P. BAYLESS

Stanley P. Bayless, director of staff sales of Thompson Products, Inc., died last Feb. 28 in an accident in Chicago. He was 45.

A star baseball player and all around athlete at Ohio University, Bayless turned down an offer from the St. Louis Cardinals after graduation to take a coaching job with the Cleveland school system. He joined Thompson Products, Inc., in 1929 as junior salesman for the service division in the Chicago area, and later served as West Coast sales representative for several years. When Thompson Aircraft Products Co. was formed in 1941, Bayless assumed direction of aircraft sales, and in 1949 he was named director of staff sales, the company's top sales position, at the main office in Cleveland, Ohio.

Bayless is survived by his wife, who was with him in Chicago at the time of the accident, and two young daughters.

DONALD L. STORY

Donald Story died April 18 in an automobile accident in Anaheim, Calif., where he resided. He was 42.

Story was a graduate in chemical engineering of Stanford University. He also held a B.A. degree from the university. For the past five years he was assistant vice-president of United Aircraft Products, Inc., of Los Angeles, but had accepted the position of production manager with Axelson Mfg. Co. shortly before his death.

FRANK J. GRAF

Frank J. Graf died March 25 at the age of 49. Graf was born in Brooklyn, N. Y., and entered the automotive field as manager of truck maintenance with the Pure Oil Co. He then joined Cities Service Co. and was active in the introduction of the power prover program of that company.

After serving in the United States Army, Graf joined the Faber Laboratories in their lubricating oil analysis program. At the time of his death he was secretary of the Otis Proving Stand Co., of New York. He is survived by his wife and one daughter.

SAMUEL S. McCUTCHEN

Samuel S. McCutchen died May 19. Originally from Elizabeth, N. J., McCutchen had been associated with Titeflex, Inc., Newark, N. J., for the past fifteen years as sales engineer and, since 1940, as manager of the Chicago branch office. He was responsible for activities in Indiana, Illinois, Minnesota and Iowa. Surviving are his wife and son.

Students Enter Industry

ROBERT J. BUDYAK (Marquette University '49) is now an assistant engineer in the atomic power department of Allis-Chalmers Mfg. Co., Milwaukee, Wis.

KENNETH DALE MILLS (Tri-State College '50) is now with Southwest Research Institute, San Antonio, Texas.

WILLIAM L. MATHEESSEN (University of Illinois '49) has completed graduate work at the University of Michigan and is now with Caterpillar Tractor Co., Peoria, Ill.

JACKSON G. BYERS (University of Michigan '50) has been recalled to active service with the Air Force at Shaw Base, S. C. Captain Byers was with GMC Pontiac Motor Division.

AUSTIN L. WOLFF (University of Colorado '50) has also been recalled to the Air Force and is a navigator with the 4th Air Rescue Squadron at McChord Base, Tacoma, Wash.

LOUIS BALDASSIN (Academy of Aeronautics '50) to Boeing Airplane Co., Wichita, Kans.

JAMES O. ANTHONY (Indiana Technical College '50) to Detroit Diesel Engine Division of GMC, Detroit.

THOMAS P. ALBRECHT (Parks College '50) to Northwest Orient Airlines, Inc., Minneapolis, Minn.

STEPHEN L. GUGLETA (Parks College '50) to Goodyear Aircraft Corp., Akron, Ohio.

ERNEST CHARLEBOIS (Detroit Institute of Technology '51) to Ford Motor Co., Dearborn, Mich.

GILBERT LEO WELLS (University of Maryland '50) to Arthur D. Little, Inc., Cambridge, Mass.

GEORGE V. DERISLEY (Lawrence Institute of Technology '50) is now in service at Puget Sound naval shipyard, Bremerton, Washington.

STANLEY J. KROL (Parks College '50) to Kaman Aircraft Co., Windsor Locks, Conn.

HARRY FRANK CRAMER (Chrysler Institute of Engineering '51) to Chrysler Corp., Detroit.

CHARLES D. CLINE (Fenn College '51) to Hydraulic Press Mfg. Co., Mt. Gileod, Ohio.

STEPHEN JOSEPH BITTO (Fenn College '51) to The Fisher Brothers Co., Cleveland.

ROLLIN E. WINEGAR (Fenn College '51) to Ohio Rubber Co., Willoughby, Ohio.

AUSTIN L. WOLFF (University of Colorado '50) is now a navigator in the Army Air Force stationed at Great Falls, Mont.

ROBERT LYNN ENGLEMANN (University of Colorado '50) is now with San Diego Gas & Electric Co., Calif.

GEORGE W. HAMPTON (Parks College '50) is with Capital Airlines, Inc., at Washington's National Airport.

GLEN O. KERREBROCK (Oregon State '50) is with the Army Air Force at McChord Base, Wash.

GLEN G. GREENE (Lawrence Institute of Technology '50) is a body draftsman with Budd Co. in Detroit.

WALTER L. LUPTOWSKI (Wayne University '50) is with Chrysler Corp. as a detailer draftsman.

LOUIS CRESSON (Southern Methodist University '50) is now a field inspector for Associated Factory Mutual Fire Insurance Co. in Denton, Texas.

IVEN CARL KINCHELOE (Purdue University '50) is with the Air Force at O'Hare Field, Ill.

LLOYD L. BOWDEN (Lawrence Institute of Technology '50) is now a tool engineer with Burroughs Adding Machine Co., Detroit.

ALVIN PRANT (Indiana Technical College '50) is with the Reeves Instrument Co. as gyro test engineer.

WILLIAM HENRICK NELSON (University of Idaho '50) is a marine engineer at the naval shipyard at Pearl Harbor.

ROBERT J. MUZZY (Massachusetts Institute of Technology '50) is now with A. O. Smith Corp., Milwaukee, Wisc.

RUSSELL F. MILLER (Parks College '50) is squadron engineering officer at Chanute Air Force Base, Ill.

JOE DAMON REYNOLDS (Northrop Aeronautical Institute '50) is in the Army at Fort Jackson, S. C.

EDWARD S. KELLERMANN, JR. (University of Minnesota '49) is with Northwest Airlines, Inc., and has been promoted from draftsman to chief draftsman.

EINARD W. LARSON (University of Massachusetts '50) is with Factory Mutual Laboratories, Boston, Mass.

ANDREW ACAMPORA (California State Polytechnic College '50) is now a technical writer for Douglas Aircraft Co., El Segundo, Calif.

MILTON E. COOK (Franklin Technical Institute '50) is the owner of Cook's Texaco Service, Manville, R. I.

JAMES MILLISON LASLEY (San Diego State College '50) is working on guided missiles for Consolidated Vultee Aircraft Corp. in San Diego.

EDWIN B. BOZIAN (Michigan State College '50) is now with Ford Motor Co., Dearborn.

EARL HENRY MOHNSEN (Cal-Aero Technical Institute '50) has joined William R. Whittaker & Co., Ltd., of Los Angeles.

DUTCH ZIGICH (California Polytechnic State College '50) is at the Mare Island naval shipyard, Vallejo, Calif.

GLEN A. WEINERT (University of Michigan '50) is an instructor in mechanical engineering at Ohio State University.

WILLIAM F. HAYES (Wayne University '50) is with Long Mfg. Div., Borg-Warner Corp., Detroit.

MURRAY B. CHIDESTER (Northwestern Technical Institute '50) is an auto salesman for Bill Reagan, Inc., Evanston, Ill.

LAWRENCE E. ANDERSON (San Diego State College '50) is working in the shock & vibrations section of U. S. Naval Electronics Laboratory in San Diego.

JOHN J. WEGER (Tri-State College '49) has been studying at Notre Dame and is now with Kaiser-Frazer at Dowagiac, Mich.

BRUCE E. BOSWELL (University of Illinois '49) has taken his M.S. degree

Continued on Page 98

SAE Fathers and Sons

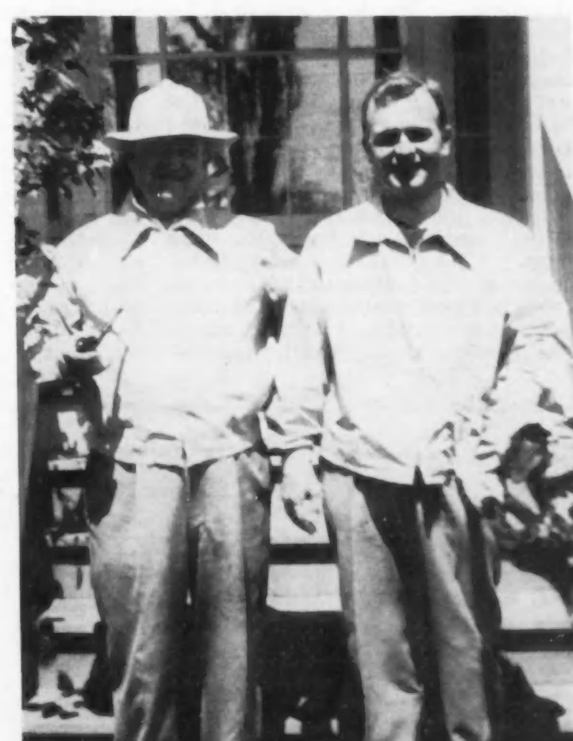
HERBERT J. HOWERTH, right, manager of Stewart-Warner Corp., Detroit, and his son, **CAPT. HERBERT J. HOWERTH, JR.,** left, of the U. S. Army Ordnance Corps. Before joining the Army Captain Howerth was chief sales engineer at the Wayne Division of Gar Wood Industries, Inc., Wayne, Mich. He is at present stationed in Detroit.

If any SAE reader knows of SAE Father-and-Son combinations, both of whom are members of the Society, your editors would appreciate hearing from you.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated—we don't want to miss any SAE grouping.

ROBERT D. OLDFIELD (left), president of Western Automatic Machine Screw Co., Elyria, Ohio, and his son, **ROBERT D. OLDFIELD, JR.,** who is sales engineer for Johnson Bronze Co. of New Castle, Pa.



14 More Boron Steels Just Published by AISI

COMPOSITIONS for 14 new boron steels have just been published by the American Iron and Steel Institute, after consultation with the SAE. The steels are

14B35	50B15	50B37	50B50
14B50	50B20	50B40	50B60
14B52	50B30	50B44	
TS50B46	50B35	50B49	

These new alternate steels contain no nickel or molybdenum. They are expected to replace in certain automotive applications some higher-alloy steels which are currently unavailable.

The 14BXX steels are boron-treated carbon steels. Both 14B35 and 14B50 contain 0.70-1.00% manganese; 14B52 contains 1.20-1.55% manganese.

The 50BXX steels — other than 50B37, 50B49, and TS50B46—contain 0.70-1.00% manganese and 0.35-0.60% chromium. Both 50B37 and 50B49 contain 0.70-1.00% manganese but 0.20-0.40% chromium. The Tentative Standard steel TS50B46 contains 0.75-1.00% manganese and 0.20-0.35% chromium.

Boron-containing compounds are, of course, to be added to the melts of all of these boron steels.

New Aero Electronics Committee To Be Formed

NEED for a special group to work on projects in the electronics field has instituted the formation of an SAE A-15, Electronics Committee. To be organized under the Aircraft Accessories and Equipment Division of the Aeronautics Committee, much of the work of this group will be aimed at assisting other committees in their standardization and specification work.

Present plans call for A-15 to (1) prepare material covering radio noise limits for electrical equipment for inclusion in SAE Aeronautical Standards, Recommended Practices, and Information Reports; and, (2) to spell out in specifications the dielectric requirements for instruments and electrical equipment.

Serving on the Committee will be liaison members from the SAE Aircraft Electrical Equipment, and Instruments Committees—two groups whose overall work will be aided by A-15's specialized projects.

W. C. Lawrence of American Airlines, chairman of the Aircraft Accessories and Equipment Division, is organizing this new Committee.

Agreement Reached On Bolt Unification

ACCORDING to Robert Cummings, the London Conferences on British, American, and Canadian bolt and nut unification were successful in that agreement was reached on standard proposals which will become effective, providing they are subsequently ratified by the standardizing agencies of the three countries.

Cummings, who is with the Ford Motor Co. and Chairman of the SAE Screw Thread Technical Committee, was a member of the American delegation attending the conference under the aegis of the American Standards Association. On return to this country, he submitted a detailed report to the SAE Technical Board through George Delaney, Technical Board Sponsor of the SAE Screw Thread Technical Committe.

Briefly stated, the proposals are selection and consolidation of existing American Standards. The need for simplification of the various product classifications has long been recognized in this country. The unification project and the urgency of the military requirement supplied the incentive to initiate immediate action.

The automotive hexagon bolt in sizes up to and including $\frac{5}{8}$ in. is combined in one series with the American Standard regular bolt in sizes above $\frac{5}{8}$ in. The American Standard light nut in sizes up to and including $\frac{5}{8}$ in. is combined in one series with the American Standard regular nut in sizes over $\frac{5}{8}$ in. The American Standard heavy bolt and the American Standard heavy nut are recognized as unified without essential change. The proposals also recognized pending changes in the American Standards which were under development by the ASA Sectional Committee. The pending revisions of the American Standards had been strongly supported by SAE and in some instances initiated by SAE.

In addition to the agreement on hexagon products, the British accepted American Standards for oval, pan, and fillister head machine screws, and undertook to study the feasibility of restricting attaching screws for military requirements to a limited selection of American Standard diameter-pitch combinations in the numbered sizes.

The members of the American delegation were deeply impressed with the friendliness and hospitality of their British hosts. Cummings said that their cooperation left no question of their sincere desire for a complete and amicable understanding as evidenced by their decision to discontinue the $\frac{1}{2}$-12 unified thread in favor of the $\frac{1}{2}$-13, long established in American practice.

As further indication of the trend toward unified standards between the three countries, Cummings mentioned that the British had been following the American Standard for self-tapping screws and that it was their intention to publish comparable standards.

The SAE Technical Board at its last regular meeting expressed appreciation to Cummings for his work as a delegate and thanks to Harold Youngren for Ford Motor Co.'s support of Cummings' trip.

Sleeve Half Bearings Spec Approved by Board

THE SAE Standard for Sleeve-Type Half Bearings was approved by the SAE Technical Board on June 22. This new Standard was formulated by the Shell Bearings Subcommittee of the SAE Engine Technical Committee.

Table 1 of the Standard lists wall thickness, wall tolerance, and housing bore for a light series of sleeve half bearings for nominal shaft diameters from $\frac{3}{4}$ to 5 in. and for a heavy series for shaft diameters from $1\frac{1}{4}$ to 5 in. Fig. 1 explains annular oil-groove contour and standard groove design.

Other portions of the Standard deal with locating lugs, flanges, spread, bearing length, end chamfer, and oil-hole location tolerance.

Edwin Crankshaw, Cleveland Graphite Bronze, has served as chairman of the Shell Bearings Subcommittee. Serving on the subcommittee with him have been Merrill Bennett, International Harvester; J. A. Lignian, Moraine Products Division of GMC; J. R. Merriam, Waukesha Motor Co.; A. R. White, Chrysler; and A. B. Willi, Jr., Federal Mogul.

SAE Aids in Seminar For Eight British Visitors

SAE cooperated in the staging of a two-day seminar on conservation of scarce materials for a group of eight British engineers on June 28–29 in Detroit. The seminar was arranged in response to a request received by Charles Chayne, General Motors' vice-president in charge of engineering, from the Technical Assistance Arrangements Branch of the Economic Cooperation Administration. Chayne asked SAE Technical Board Chairman Stanwood Sparrow for the assistance of the Society in making arrangements.

The British specialists are touring the United States to study measures being taken and planned for the conservation and efficient utilization of scarce materials. They are Sir Graham Cunningham of Triplex Safety Glass, H. W. Bowen of E.M.I. Factories, F. E. Chappell of Harold Whitehead & Partners, F. V. Everard of Belliss & Morcom, John Hampson of Leyland Motors, D. A. Oliver of the British Ministry of Supply, Maj. P. L. Teed of Vickers-Armstrong, and Bertram White of the Federation of British Industries. All are members of the Specialist Group on Conservation of Scarce Materials of the Anglo-American Council on Productivity.

The British were welcomed to the Detroit seminar by SAE Technical Board Chairman Stanwood Sparrow, who launched the opening session, and Charles Chayne, new chairman of the Automobile Manufacturers Association Engineering Advisory Committee.

The visitors were assured that the lean alloy steels developed here during World War II like the SAE **86XX**, **87XX**, and **94XX** series—which are considerably leaner than the alloy steels generally used by the British—gave such good service that their use continued in peace time.

It was explained that metallurgists in this country are turning to boron steels in an effort to get along on far smaller alloying contents even than they used in World War II. The visitors were interested, but they pointed out that before they can adopt this conservation measure, they will first have to establish facilities for producing the ferro-boron compounds needed to make boron steels.

This country's automotive industry is economizing on nonferrous metals, too, the British heard. The tin content in solder has been cut about 30%. Wire gage has been reduced in such secondary wiring circuits as tail lights, dome lights, and instrument panel lights. Practically no nickel or aluminum is being used in electrical equipment, and use of copper and tungsten has been reduced.

Discussion of the American magnesium situation disclosed that, because of the boost in aircraft production, there may be a magnesium shortage in the offing. There is plenty of magnesium available from sea water, but there is a limited amount of electrical power to process it. It takes about 9 kw-hr to process 1 lb of magnesium, engineers were reminded. There is no backlog of magnesium scrap like the aluminum scrap backlog because little magnesium has been used since the end of World War II.

It was reported that this country can expect to have a continuous rolling mill for magnesium in operation sometime in 1952.

Topics for the Thursday sessions included materials substitutions, emergency specifications and standards, and direct economy measures such as reduction and recovery of scrap. American participants in the morning session considering ferrous and nonferrous materials were E. H. Stilwill of Chrysler, F. C. Young of Ford, David Milne of General Motors, R. W. Roush of Timkin-Detroit Axle, and V. A. Crosby of Climax Molybdenum. Thursday afternoon, E. T. Johnson of Chrysler, Joseph Gurski of Ford, E. F. Webb of Chrysler, W. M. Phillips of General Motors, and A. W. Winston of Dow Chemical extended the discussions to tin and solder, electrical equipment, plating and plastics, and magnesium.

On Friday morning, C. F. Nixon of GMC's Ternstedt Division and E. J. Storfer of Chrysler led the seminar's discussion of substitution of plastics and other nonmetallics for metals.

The Friday afternoon session delved into three topics. Two GMC men, William Vann of Pontiac Motor Division and S. C. Varblow of the Detroit Diesel Division, explained American practices on scrap recovery. Robert Podlesak of Chevrolet answered questions on factory reorganization for improvement of economy. John Moran and Daniel Holgrave of General Motors acquainted the British with American efforts to increase cooperation between material suppliers and users.

Members of the British group will report back information gleaned from this seminar and the other events arranged for their tour to their respective sponsors. These include the British Electrical & Allied Manufacturers' Association, the Trades Union Congress, the British Engineers' Association, the Society of Motor Manufacturers & Traders, the Ministry of Supply, and the Society of British Aircraft Constructors.

Thickness Revised In Piston Ring Spec

THE recent revisions to the SAE Standards and SAE Recommended Practices on piston rings and grooves include, among many other changes, numerous changes in prescribed piston ring radial wall thickness. The revisions were approved by the SAE Technical Board in June.

The new wall thicknesses were calculated from a formula based on maximum stress. Both new and old thicknesses are plotted in Fig. 1. This graph shows that the difference between new and old values is greatest for cylinder diameters around 5¼ in. The difference is 0.014 in. for the 5¼-in. cylinder. Rings made according to the new Standard will fit without interference in existing pistons.

As D. M. Smith—chairman of the group which prepared the revisions—explains it, the changes in wall thickness will enable the piston ring manufacturer to produce rings which will insure still better control of oil and blowby. This will result in improved engine performance.

Besides the former and the revised wall thickness values, Fig. 1 shows the wall thicknesses set up for a new series of thick-wall compression rings ⅛ in. or less in width. The revised SAE Standard on Piston Rings and Grooves will include this information tabulated with corresponding maximum ring groove root diameters.

Smith has served as chairman of the subcommittee which drew up the revisions. Others collaborating on the revisions were J. H. Ballard, H. G. Braendel, A. M. Brenneke, R. H. Colvin, Lee Doty, C. L. Gough, D. W. Hamm, D. P. Kearney, W. C. Knoebel, Paul Lane, J. N. Lowe, G. C. Mayfield, Stuart Nixon, C. W. Ohly, H. M. Olson, J. Pennington, R. A. Snyder, F. X. Speaker, R. D. Taber, J. C. Thompson, and E. H. Viele.

The revisions were not approved in time for the 1951 SAE Handbook, but copies of the material as revised are available from the staff secretary, D. L. Staiger, 29 West 39 Street, New York 18, N. Y.

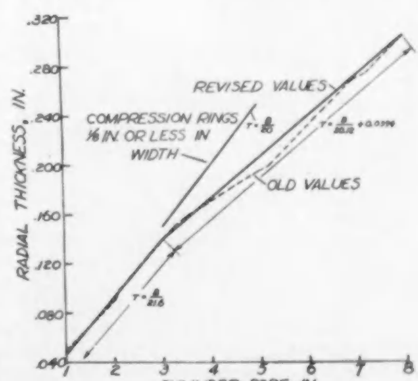


Fig. 1—Piston ring radial wall thickness

New Aero Drafting Manual Revision Out

THE SAE Aeronautical Drafting Manual continues to be kept fresh and up-to-date by its author Committee. Recent addition to the present volume of over 40 new pages marks the second time within three years that a revision kit this size has been prepared by the SAE Aeronautical Drafting Manual Committee.

Most of the pages in this latest revision cover new material. One section describes the use of pictorial type drawings as aids to better visualization in design work. Another shows ways of indicating on drawings all types of aeronautical welding.

Also included is a new method of dimensioning holes in groups, the latest ideas on use of 2-place and 3-place decimal systems for dimensioning, and a section on the right and wrong ways of showing sectional views on drawings.

Of special interest is information provided on drawing numbering systems, drawing materials, and different types of drawing reproduction processes.

Present owners of the Manual can modernize their copies by ordering this revision package from the SAE Aeronautics Department. (Use in the Manual of the Dewey decimal system for page-numbering greatly simplifies the job of inserting these new pages in their proper places.) Up-to-date, completely revised Manuals are also available. Prices: Complete Manual, \$3.00; revision kit, \$1.25; additional cost for Manual leatherette loose-leaf cover, \$2.00.

Chairman of the SAE Aeronautical Drafting Manual Committee is Otto E. Kirchner, American Airlines.

Technishorts . . .

"CONSERVATION OF RUBBER IN THE M-38 (JEEP)," SAE's report to the Army, has been delivered to Maj.-Gen. Ward H. Maris, Deputy Assistant Chief of Staff, G-4, Logistics, for Research and Development. General Maris wrote the Secretary of the SAE Technical Board that "the information contained in this report is greatly appreciated in view of the degree to which rubber conservation must be carried out." A. J. Kearfott was chairman of the committee that wrote the report.

RECENT TEST PROGRAM WORK indicates that the columbium plus tantalum to carbon ratio in 18-8 alloys should be a minimum of 10 to 1, reports the Corrosion and Heat Resistant Alloys Committee of the SAE Aeronautical Material Specifications Division. Tests made on several heats of this alloy, to which varying amounts of columbium plus tantalum were added, provide substantial evidence that a 10 to 1 ratio is adequate to insure satisfactory performance. Corrosion resistance and strength qualities were found to be impaired when lower ratios were used. This confirms the Committee's recommendation made some time ago that specifications for this alloy, exclusive of welding rod, should call for a 10 to 1 ratio.

SHOT-PEENING DEVELOPMENTS will be discussed at a three-day meeting, September 19, 20, and 21, at The Homestead, Hot Springs, Va. Sponsor of the meeting is Division XX—Shot Peening of the SAE Iron and Steel Technical Committee. Those intending to go to the meeting should notify the SAE Detroit Office, 808 New Center Building, Detroit 2, Michigan.

AT THE ARMY'S REQUEST, SAE has set up a committee to evaluate test equipment and facilities at Aberdeen Proving Ground. Members are O. K. Butzbach, T. J. Carmichael, A. W. Frehse, C. E. Hering, I. E. Johnson, W. M. May, and F. M. Watson. Harry Bernard is Technical Board sponsor. The committee held a preliminary meeting in Detroit on June 28 and met at Aberdeen on July 18 to begin its inspection. Carmichael was chosen chairman at the July 18 meeting.

Dimensions Discussed For Larger Flywheels

SAE specifications for flywheels and clutch housings will be extended to cover heavy-duty engines and assemblies for earthmoving equipment, it is expected. This is the goal of Subcommittee VI—Engines of the SAE Construction and Industrial Machinery Technical Committee and the Flywheels Subcommittee of the SAE Engine Technical Committee. The two subcommittees have been meeting jointly.

Tolerances for flywheel housing eccentricity and face squareness have been proposed and seem to be acceptable to most subcommittee members. Dimensional specifications for drive-ring-type-clutch flywheels have also been proposed.

Every effort is being made to consolidate standards for 24 in. single-plate and double-plate clutches, thereby reducing the total number of flywheel designs required. Also, consolidation of the 11½-in. single-plate and double-plate clutch standards is under study.

Air Cleaner Code Now Under Revision

THE SAE Air Cleaner Test Code Subcommittee of the SAE Tractor Technical Committee is at work on a revision of the code to bring it up to date.

The revised code, like the code it is designed to supercede, is intended for use with air cleaners for tractors, construction machinery, and other off-highway equipment—not for trucks or passenger cars. The subcommittee has already drafted the "Materials and Apparatus" section.

Subcommittee members agree that oil characteristics affect oil-bath air cleaner test results. Now they are seeking to find out what characteristics of oils are important. At the June 14-15 meeting of the subcommittee, it was settled that G. H. Lancaster, of the Melrose Park Works of International Harvester, should procure oil samples from five different refineries. Lancaster is to distribute portions of all samples to each of several laboratories for the running of oil loss tests in production cleaners. The laboratories will record weight of oil lost, weight of oil in cup, and airflow. From this data, subcommittee members hope to discover which characteristics of the oil affect test results and may therefore need to be specified for the test oil.

W. H. Worthington is chairman and W. W. Lowther is vice-chairman of this subcommittee of the Tractor Technical Committee.

SAE Section Meetings

Visiting Chairman Speaks at Baltimore

May 10—Central Illinois Section Chairman John Findeisen, of Caterpillar Tractor Co., was guest speaker at Baltimore Section's last meeting this year. Host for the meeting, at which Findeisen discussed "Development of Earthmoving Equipment," was the Alban Tractor Co.

Gives Tips on Idea-Hunting

• Central Illinois Section
Harlow Piper, Field Editor

May 28—"How to Hunt Ideas" was the title of an interesting talk given by **Howard Houpt**, vice-president in charge of the Chicago office of Batten, Barton, Durstine and Osborn, Inc. The talk was taken from Alex Osborn's latest book "Your Creative Power," and was illustrated with slides.

Osborn's formula for hunting ideas is based on two premises: First, the more ideas we pile up, the more likely we are to hit on a good idea. Second, there are ways by which we can make ourselves think up more ideas.

The basic technique for getting the most out of our imaginations is to ask ourselves certain questions which may be grouped as "what else?" and "how else?"

Thinking up additional uses can often widen markets for old products. The S.O.S. scouring pad got its start in the kitchen sink, but its ability to clean white-wall tires opened a market consisting of 16,000,000 white-walled tires.

The "Book of the Month" started a series of "of the month" ideas such as the "Gadget of the Month," "Flower of the Month," and "Fruit of the Month."

Turning the idea of the glass bottom boat upside down yielded the glass domed cars used on railroads.

"What other shape?" is a good question. Wheels have always been round, but an oval wheel might take the place of a round wheel for heavy pulling.

An example of combination in aviation is the hooking up of jet propulsion with engine power. Supplementary rockets enable a plane to rise five times faster than with only its own motor.

Leonardo Da Vinci invented the roller bearing, but Henry Timken asked himself "Is there a better shape?" He tapered it and devised a bearing that would take punishment from any direction.

Sometimes the very life of a new product depends on thinking up many new uses. Helicopters may turn out to be museum pieces unless someone thinks up enough new jobs which they can do better than anything else. Besides carrying mail to suburbs, helicopters are now used for patrolling high-tension lines over the mountains.

In hunting ideas, one should first state the problem and then jot down all the ideas that come to mind, no matter how impractical they might seem. Very often an impractical idea leads to a good idea.

Houpt explained how a group of people can "brainstorm" a problem with greater success than by individual effort. An idea from one person will start a chain reaction of ideas by others. No criticism of ideas is allowed during the "brainstorm" session, and the ideas are evaluated afterwards. Wild, impractical ideas are welcomed, because it is easier to tone down than to think up, and because they give a fresh approach to a problem that can suggest good ideas.

By following these simple rules, Osborn believes that everyone can step up his creative power to achieve more happiness in his personal life as well as to get ahead faster in his job.

Evaluates Performance Of Turbojet Aircraft

• Mid-Continent Section
D. W. Frison, Field Editor

May 11—Mid-Continent Section wound up a successful year with its annual "Ladies Day" at the Hillcrest Country Club in Bartlesville, Okla. The day's activities included afternoon bridge, golf, and tours of the beautiful and spacious Adams Building and modern automotive laboratories of the Phillips Petroleum Co. Following an excellent dinner, Chairman W. K. Randall turned over his gavel to Dr. D. R. Frey who will lead the Section's 1951-52 activities. Chairman Frey's officers were

Baltimore — **Baltimore**

Speaker John Findeisen addressing Baltimore Section members

G. L. Coleman accepting election as Baltimore Section chairman for 1951-52

John Nahm, advertising manager of Alban Tractor Co., presenting the door prize—a miniature Caterpillar—to Russell Hull

Mid-Continent Section's new officers, introduced at the May 11 meeting (left to right): Dr. D. R. Frey, chairman; H. C. Baldwin, vice-chairman; Frank DeVore, vice-chairman for Transportation & Maintenance; Harold Quigg, treasurer; William Ford, secretary; E. W. Cave and Harold Trimble, Section delegates; and Leo McReynolds, Section representative

Four golfers ready to tee off at Mid-Continent Section's annual outing, May 11. Left to right: W. K. Randall, Carter Oil Co., 1950-51 Section chairman; L. P. Calkin, Phillips Chemical Co.; James Davis, Phillips Petroleum Co.; and G. D. Priestman, Carter Oil Co.

introduced to the gathering before **W. Slater O'Hare**, chief powerplant engineer of Douglas Aircraft Co.'s Tulsa Division took over as speaker for the evening session.

O'Hare, a mechanical engineer graduate of Iowa State, has been directly associated with the aircraft industry since 1942. He was wind tunnel test engineer at NACA and test engineer at Aerojet Engineering Corp. in addition to being design and flight test engineer for Douglas. While in the Air Force, he was flight test engineer of the B-29 "Dreamboat" on the record-smashing Guam to Washington, D. C. flight.

In his paper "An Introduction to the Aircraft Turbojet Engine," O'Hare described the basic principles of jet propulsion and the turbojet engine in particular. The turbojet is one of several powerplants envisioned to increase the flight velocity of aircraft, and one now in practical use. No one type has been developed which fulfils all needs and each has its own particular limits. Each type has gone or is undergoing development programs to perfect its performance within its band of application and also to widen these limits. Turbojet engines now produce 5200 lb of thrust and indications are that this figure will be increased very shortly.

A turbojet produces power by changing the momentum of its operating medium. Since power is proportional to the product of the exerted force and the velocity of the machine, power is not realized until the engine has motion. Doubling jet engine speed doubles power output of the engine.

Since jet engine power is proportional to speed, the same calculations that exist for high speeds also exist for low speeds. Consequently, the power available for acceleration to take-off speed is very low, giving longer take-offs. In addition, the fuel economy is poor; thus the continued use of reciprocating engines in slow speed transport planes. For instance, at 375 mph, thrust is equivalent to horsepower. Hence, if a propeller-driven airplane required the same power as a jet airplane at that speed, the jet engine would consume fuel at about twice the rate of the other engine.

Turbojet engines, like all other types of aircraft engines, require accessories such as fuel meter regulator, oil pumps and lube system with cooler, starter, ignition coil, spark plugs, anti-icing devices, retractable inlet air screen, hydraulic system, electrical generator, and compression discharge air system for heating and pressurizing the cockpit.

Turbojet engines are rigidly mounted because all operations of the engine are continuous, thus vibration is cut to a minimum. The engines roar at full speed, but the noise is not observed by the pilot or plane occupants. The exhaust gas temperature of a stationary engine sometimes reaches 1000 F at a velocity of 820 mph. A man standing 100 ft directly behind exhaust nozzle would not be comfortable.

Low slung air intakes present problems as air picks up foreign objects which are damaging to compressor blades and turbine buckets. Screen systems with retractable screens help to reduce or eliminate engine injury. Inlet air restriction by icing can have damaging effects, such as complete engine failure unless critical engine parts are heated with some of the discharge compressor air.

Average overhauls range from 300-400 operational hours while a period of 1000 hr is not unusual for some reciprocating engines. Since there are

ew moving parts in a turbojet, parts eplacement becomes simplified and nore frequent overhauls can be tolerated.

The lack of power at slow speeds and he high rate of fuel consumption must e recognized so that this machine may e used to its best advantage. This engine with its continually accelerating development is providing aircraft designers with the power package to which they have been looking forward.

You'll Be Interested To Know . . .

Established in 1915, but unable to survive World War I, THE SAE STUDENT BRANCH AT CORNELL UNIVERSITY is again active. An informal SAE Club started by the students several years ago proved so successful that the Council renewed the original charter. Prof. E. B. Watson, immediate past chairman of SAE Syracuse Section, is faculty adviser for the group.

THE UNIVERSITY OF WASHINGTON, Seattle, CAL-AERO TECHNICAL INSTITUTE, Glendale, Calif., and STEVENS INSTITUTE OF TECHNOLOGY, Hoboken, N. J., are the most recent schools at which SAE Student Branches have been established. Informal SAE Clubs at these schools have earned the support of their respective faculties and the Student Committees of local SAE Sections. Council action granting Student Branch Charters was taken at the recommendation of the Society's Student Committee headed by W. A. Casler. Faculty advisers for the new Student Branches are: Michael Guidon, University of Washington; A. J. Victor, Cal-Aero Technical Institute; and Prof. Eugene H. Fezandie, Stevens Institute of Technology.

The SAE now has 40 Student Branches. Student enrollment tops 5000.

Hear Report on Famous Road Races

• Pittsburgh Section

H. K. Siefers, Field Editor

May 16—Sports car racing in this country and its technical aspects were the features of Pittsburgh Section's traditional all-day spring meeting at the Wanango Country Club in Oil City.

W. F. Milliken, Jr., manager of flight research, Cornell Aeronautical Laboratory, reviewed the history of European road racing before showing his very excellent pictures of the Pikes Peak and Watkins Glen races which comprised the history of the sport in the U.S.A.

Practical values of sports car racing were readily envisioned as Milliken explained the mechanical feats achieved in these cars and the practical experimentation necessary to prepare a car for such races. Horsepower as high as 3.71 per cu in. of displacement with engine weights of less than one pound per bhp has been achieved in some of these cars. Other valuable data on roadability and performance have been gained by the keen competition between rear-wheel drive, front-wheel drive and four-wheel drive units. For instance, it was found that for the best cornering on the hairpin curves of the Pikes Peak course the optimum location of the center of gravity was 65% of the distance from the front axle to the rear axle.

The amazing popularity which road racing has achieved in this country in just a few years is exemplified by the 100,000 spectators at last year's Watkins Glen race. In the Grand Prix that year, the winner achieved a 72 mph average which is comparable to European road racing.

Milliken's pictures also showed the interesting Concourse d'Elegance at Watkins Glen. For the uninitiated, this is a pompous parade of racing and sports cars of all vintages and also a few priceless museum types of which the owners are justly proud. Prizes are awarded in different categories.

Under the sponsorship of Fred Haller of Pittsburgh Section and Bill Bonder of the Steel City Region of the Sports Cars of America, some 20 to 25 Sports Car enthusiasts drove their small but fast models to the meeting and had them on display during the afternoon. Jaguars, MG's and a Ford 175-hp conversion unit were among those present. The clicking of camera shutters was much in evidence as members inspected these mighty mites and admired their trim and practical lines. The exposure of rear wheels on most

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Pittsburgh Section members inspecting some of the sport cars on display during the all-day meeting in Oil City. At far right is Murray Fahnestock, editor of Ford Field Magazine and former Pittsburgh Section field editor

SAE at Rensselaer

At Rensselaer Polytechnic Institute, the nation's oldest school of science and engineering, SAE "fits in"—fits into the life of RPI through activities open to all members of the Institute; fits in with SAE through close cooperation with the SAE Mohawk-Hudson Group.

Set high above the Hudson valley at Troy, N. Y., Rensselaer has a tradition of pioneering. In 1835, 11 years after its founding, RPI granted the first engineering degrees given in an English-speaking country. The Institute was one of the earliest schools to use laboratories as a regular part of instruction and to sponsor field trips, first to sites of interest to students of biology and geology, later to industrial centers as well. In a seeming paradox, the Institute has a tradition of modernity, of using the latest means to accomplish its enduring aim: "the application of science to the common purposes of life," as Stephen van Rensselaer described it.

The few early laboratories have now grown into "a campus of laboratories" with more than 40 major labs, and the first few visits to local factories have led to RPI's cooperative five-year program with industry. Under this program outstanding students, selected jointly by the faculty and the company participating, follow the usual curriculum for one year and thereafter alternate each term of academic work with one of industrial practice in the fields of their specialization. They are paid normal wages during the working periods. At the end of four years these students receive bachelors' degrees, and after the fifth year, masters' degrees, having completed all the academic requirements and had 64 weeks of on-the-job experience as well. The mechanical engineering department, with Neil P. Bailey as chairman, is the department most active in this program, and members of the mechanical engineering faculty, too, are encouraged to alternate periods of teaching with advanced study and service in industry.

To keep in touch not only with theoretical and technological advances but with the needs and problems of industry as well is the aim of the program. Speaking of this kind of cooperation on the occasion of RPI's 100th anniversary, Herbert Hoover said, "Without this link for the skilled application of science to need, science itself would have to a large degree remained locked up in the libraries and laboratories."

Other students planning a career in engineering prefer to broaden their academic experience by attending a college of liberal arts before starting their professional study. Rensselaer has completed arrangements with four colleges for a combined study program, also covering five years: students may attend one of the colleges of liberal arts for three years, specializing in science and pre-engineering courses. They will then enter the Institute for two years of engineering. At the end of this course of study the student will receive a B.S. degree from the college of liberal arts and a B.E. degree from Rensselaer. Most students still choose to follow the regular four-year curriculum but these two plans offer varied programs to students with special aims.

Between-classes rush from Russell Sage Laboratory, home of the mechanical engineering department at Rensselaer Polytechnic Institute. RPI is the nation's oldest science and engineering school, presently has an enrollment of 3500 and 12 degree-granting courses of study

Branches of professional and scientific societies are encouraged and flourish at Rensselaer. SAE came to the Institute after the war. In 1946, Eugene Bohun, Arthur Aymar and several others formed an SAE club; through their enthusiastic work the club became a chartered Student Branch the following spring with Eugene Zak as first chairman. For the next few years its membership doubled each year, and at the beginning of the fall term last year numbered 102 students, drawn mostly from the mechanical and aeronautical engineering departments. Dale H. Brown, now with General Electric Co., was faculty adviser for the first three years; John F. Hill, of the mechanical engineering department, has now taken over the post.

From its founding the RPI Student Branch stressed meetings and projects of general interest, open to all. Movies are scheduled for afternoon sessions as a service to the whole student body. Local industrial field trips arranged by the officers, often through the cooperation of members of the Mohawk-Hudson Group, are publicized well ahead of time and open to everyone who signs up. Students have thus made tours of such places of interest as Watervliet Arsenal and the Green Island plant of Ford Motor Co. One professor dismissed his whole class to join in on a tour of General Electric Co.'s steam turbine plant, so that two trips were necessary to accommodate the crowd.

Russell Sage Laboratory, the center of mechanical and electrical engineering at RPI, is available to the SAE Student Branch, and there members experiment with such engine design features as water injection and various compression ratios to determine their effect on specific fuel consumption and other variables.

The Mohawk-Hudson Group of SAE deserves credit for its warm cooperation with the Student Branch. Many Student Branch programs have been given or arranged by Mohawk-Hudson Group members, such as D. C. Peroutky's talk on the high-frequency ignition system he was then testing in his own Nash. The late Austin M. Wolf spoke on his inspection of enemy vehicles after the war, illustrating his lecture with slides of American and foreign cars, at a meeting that drew

Polytechnic Institute

so many visitors that it had to be moved to a larger hall. Other memorable lecturers were Eugene Baehle on aircooled military engines, A. O. Hodge on diesel electric locomotives, and E. M. Barber on the Texaco combustion process.

Past secretary Howard Roberson, now of Ingersoll-Rand Co., past chairman Francis Hunt, Ed Vasburgh, Dick Edson, now of Owens-Corning Fibreglas Corp., and the present officers, John Martin, Philip Peterson, Frank Thompson and William Spicer, share credit with many others for the vitality of the RPI Student Branch in its first five years. Dale Brown, its first faculty adviser, described the SAE branch as "the most dynamic group I have ever been associated with," and its record of enthusiastic activity promises continued growth in the future.

The Following SAE Members Attended Rensselaer Polytechnic Institute:

Fred E. Amon, Jr. (**1927-31**), Donald C. Appelby, (**1938-42**), Arthur A. Aymar (**1946-47**), Matthew A. Batson, Jr. (**1935-39**), Clay P. Bedford (**1920-25**), William J. Bigby, Jr. (**1946-50**), Francis A. Breen (**1930-34**), Sherman W. Bushnell (**1916**), John P. Casserly (**1930-32**), Willett S. Chinery (**1913-15**).

Frank T. Christian (**1926-27**), Rossa W. Cole (**1934-39**), William S. Coleman (**1925-29**), Charles H. Crockett (**1908-12**), J. J. Crookston (**1918-22**), Robert W. Curran (**1940-47**), Thomas P. Dallow (**1936-40, 1946-47**), Clarence E. Davies (**1910-14**), R. G. DeLaMater (**1917-21**), Spencer W. Deming (**1928-32**).

L. H. DeWyk (**1928-32**), Harry P. Dobrow (**1933-37**), Carl T. Doman (**1918-20**), G. M. Douglass (**1944-45**), Hal B. Drapeau (**1919-23**), Ellwood M. Easton, Jr. (**1939-42**), John C. Eckert (**1945-49**), M. H. Elkin (**1927-31**), C. Stewart Ferguson (**1914-18**), J. G. Findeisen (**1932-36**).

Leo P. Flood (**1919-23**), Howard W. Frank (**1932-33**), Vollmer W. Fries (**1920-24**), Fred J. Garbarino (**1929-33**), Milton L. Gearing (**1920-23**), W. Hayward Geddes (**1929-34**), Stuart P. Hall (**1936-40**), Ivan Harkleroad (**1933-37**), Paul K. Heim (**1946-48**), William R. Hopkins (**1926-30**).

Ilia Islamoff (**1923-25**), Carl A. Jacobson (**1914-18**), A. Burton Jones, Jr. (**1929-33**), Edward M. Kaliff (**1946-50**), David H. Kaplan (**1941-43, 1946-49**), Samuel Koffsky (**1919-23**), Carl A. Krohne (**1933-37**), Kenneth I. Langwig (**1946-47**), Joseph H. Leggett (**1936-40**), Richard B. Lewis (**1937-41**).

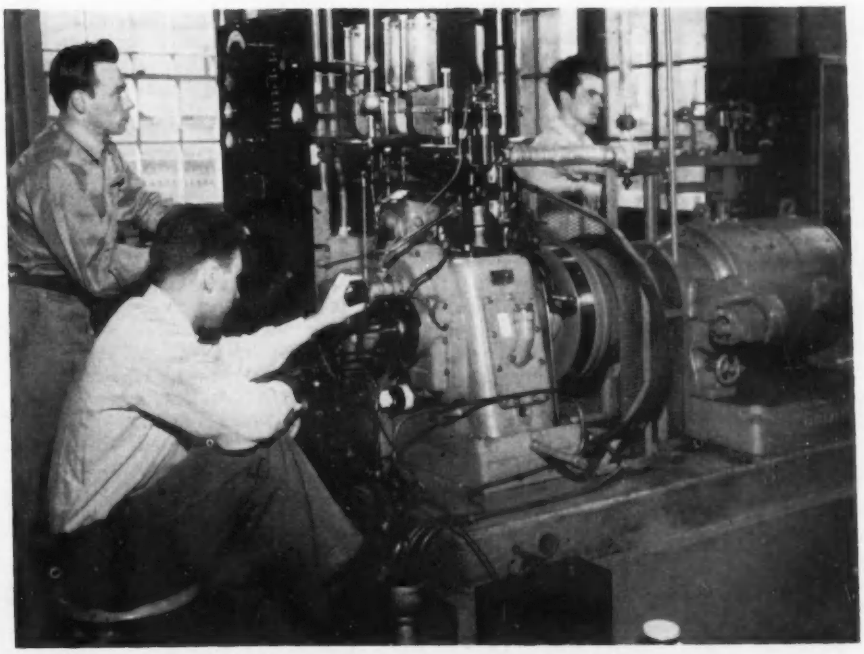
C. G. MacDermot (**1945-49**), Ernest A. Magyar (**1936-40**), Emmett C. Manning (**1945-49**), Philip R. Marvin (**1933-37**), George J. McTigue (**1938-42**), Arnold G. Medbery (**1946-48**), Fearson S. Meeks (**1917-19**), Donald V. Miller (**1941-48**), Douglas H. Moreton (**1938-41**), Robert W. Morgan (**1924-28**).

Louis F. Muller, Jr. (**1937-42**), Howard Murray (**1923-27**), Stephen R. Nemeth (**1945-49**), Raymond J. Novotny (**1948-49**), Irving A. Oehler (**1928-35**), Earl Pine Osborn (**1916-18, 1919-21**), Irving B. Osofsky (**1941-44**), Roger E. Pardon (**1940-48**), James R. Petters (**1943-46**), R. E. Phelon (**1929-33**).

Earle W. Pughe (**1919-23**), Joseph T. Ratau (**1941-42**), Frederick W. Recknagel (**1925-30**), Richard J. Reich (**1944-45, 1947**), Howard A. Roberson (**1943-44, 1946-48**), Lawrence M. Rose (**1939-43**), Wilmot Sandham (**1922-25**), James M. Scofield (**1935-38**), George J. Scranlon (**1932-37**), Robert H. Semenoff (**1936-40**).

H. M. Setapen (**1931-35**), George S. Sherman (**1934-39**), S. E. Skinner (**1914-20**), Robert L. Sommerville (**1913-16**), W. Thomas Stark (**1934-38**), Gardner S. Staunton (**1919-23**), Edward Stawski (**1946-50**), Donald Stoltman (**1944-47**), Charles H. Sweeney (**1936-41**), Paul B. Taylor (**1913-15**).

John R. Tully (**1938-42**), John J. Tyne (**1925-29**), Marsden Ware (**1914-18**), Robert A. Wells (**1936-40**), Joseph A. Wisely (**1937-41**), A. S. Zimmer (**1935-40**).



SAE members at Rensselaer Polytechnic Institute check the critical compression ratio for a specific fuel. CFR engine shown is installed in RPI's mechanical engineering laboratories. Students are (left to right): John Martin, chairman of SAE chapter at RPI, Paul Meyer, and Jeremiah Ferguson

SAE Section Officers

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Vice-chairman: **Harold D. Duppstadt**, automotive engineer, Department of the Army, Automotive Division, Development Proof Services, Aberdeen Proving Ground; vice-chairman, Aeronautics: **Albert S. Polk, Jr.**, senior layout designer, Glenn L. Martin Co.; vice-chairman, Transportation and Maintenance: **Ward L. Bennett**, superintendent of automotive equipment, Baltimore Transfer Co.; treasurer: **Earl S. Clifton**, automotive engineer, Department of the Army, Ordnance Department, Automotive Division, Development and Proof Services, Aberdeen Proving Ground; secretary: **Robert M. Foster**, mechanical engineer, U. S. Naval Engineering Experiment Station, Annapolis.

British Columbia

Chairman: **Burdette Trout**, Sales, Truck Parts and Equipment, Ltd.

Vice-chairman: **Edward C. Howell**, transportation manager, Evans, Coleman & Evans, Ltd.; vice-chairman, Fuels and Lubricants: **Ernest R. Carswell**, coast branch manager, Aviation specialist, Standard Oil Co. of British Columbia, Ltd.; vice-chairman, Transportation and Maintenance: **Elliot G. Barber**, service foreman, International Harvester Co. of Canada, Ltd.; treasurer: **Alan B. Reid**, truck sales manager, Ross Baker Motors, Ltd.; secretary: **John B. Tompkins**, editor, Westrade Publications.

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for 1951-52

terson Air Force Base; vice-chairman, Columbus: **Fred B. Dahle**, technical adviser, Battelle Memorial Institute; vice-chairman, Springfield: **T. E. Martin**, chief engineer, Oliver Corp.; treasurer: **Lewis A. Leonard, Jr.**, assistant project engineer, Aeroproducts Division, GMC.; secretary: **Thomas O. Mathues**, supervisor, physical test, Inland Mfg. Division, GMC.

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Vice-chairman: **Philip H. Pretz**, assistant car engineer, Lincoln-Mercury Division, Ford Motor Co.; vice-chairman, Aeronautics, **Thomas B. Doe, Jr.**, manager, Aircraft Products Sales Division, Vickers, Inc.; vice-chairman, Body: **Henry C. Grebe**, chief body engineer, Ford Motor Co.; vice-chairman, Engineering Materials: **Arthur E. Proctor, Jr.**, manager, chemical engineering, Tractor and Industrial Engineering Division, Ford Motor Co.; vice-chairman, Junior Activity: **Vincent Ayres**, assistant to chief engineer, Eaton Mfg. Co.; vice-chairman, Passenger Car: **J. P. Butterfield**, assistant chief engineer, development design, Chrysler Corp.; vice-chairman, Production: **Rodger J. Emmert**, executive, charge of facilities and processes staff, GMC.; vice-chairman, Regional: **R. D. Kelly**, assistant to original equipment sales manager, Electric Auto-Lite Co.; vice-chairman, Students: **Bernard W. Bogan**, chief engineer, Dodge Division, Chrysler Corp.; vice-chairman, Truck and Bus: **John R. Bartholomew**, assistant sales manager, Axle Division, Eaton Mfg. Co.; treasurer: **George A. Delaney**, chief engineer, Pontiac Motor Division, GMC; secretary: **Kenneth E. Coppock**, director, engineering division, Fisher Body Division, GMC.

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Indiana

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Vice-chairman: **Robert P. Atkinson**, assistant turbine engineer, Allison Division, GMC.; treasurer: **J. V. Gaebler**, chief product research engineer, International Harvester Co.; secretary: **J. H. Coover**, manager, production and research, D-A Lubricant Co., Inc.

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Chairman: **Delton R. Frey**, manager, products application, Deep Rock Oil Corp.

Vice-chairman: **Harold C. Baldwin**,

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M. P. Jolley

J. T. Greenlee

R. C. Williams

L. C. Raymond

H. E. Churchill

A. C. Hazard

Chairman

Robert Insley

SAE Section Officers for 1951-52—Continued

engineering representative, Continental Oil Co.; vice-chairman, Transportation and Maintenance: **Franklin E. DeVore**, fleet engineer, Ethyl Corp.; treasurer: **Harold T. Quigg**, research engineer, Phillips Petroleum Co.; secretary: **W. F. Ford**, superintendent, Product Use Laboratory, Continental Oil Co.

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Chairman: **Glenn L. R. Baumhardt**, vice-president, charge of sales and engineering, Redmond Co., Inc.

Vice-chairman and secretary: **M. D. McCuen**, senior project engineer, Oldsmobile Division, GMC.; treasurer: **Edward Latta**, project engineer, Redmond Co., Inc.

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Chairman: **Charles H. Duquemin**, engineer, LeRoi Co.

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Vice-chairman: **Hermann L. Eberts**, assistant purchasing agent, Canadair, Ltd.; vice-chairman, Ottawa: **E. L. Simpson**, vehicle development division engineer, Department of National Defense, Directorate of Vehicle Development; treasurer: **H. L. Barre**, district sales manager, Thompson Products, Ltd.; secretary: **Frederick H. Moody**, manager, industrial sales, Imperial Oil, Ltd.

New England

Chairman: **Lewis B. Ebbs**, manager, Superior GMC Truck Sales and Service, Inc.

Vice-chairman: **Lewis P. Hankins**, superintendent of equipment and purchasing agent, Hemingway Bros. Interstate Trucking Co.; treasurer: **Arnold R. Okuro**, instructor, charge of Automotive Department, Franklin Technical Institute; secretary: **James K. Miller**, manager, Boston branch, Wagner Electric Corp.

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Chairman: **William G. Nostrand**, vice-president, charge of engineering and sales, Winslow Engineering Co.

Vice-chairman: **James E. Glidewell**, chief engineer, Hall-Scott Motor Division, ACF-Brill Motors Co.; vice-chairman, Aeronautics: **Morris H. Pomeroy**, powerplant engineer, United Airlines, Inc.; vice-chairman, Diesel Engines: **Warren G. Brown**, research staff engineer, Caterpillar Tractor Co.; vice-chairman, Fuels and Lubricants: **Grant M. Wheeler**, supervisor, Fuel Research Laboratory, Tide Water Associated Oil Co.; vice-chairman, Transportation and Maintenance: **Norman K. Reinhard**, sales representative fleet, Chrysler Corp.; treasurer: **Robert E. Jeffrey, Jr.**, product application and development engineer, Shell Oil Co., Inc.; secretary: **Laurence L. Moore**, 1st vice-president, factory manager, Winslow Engineering Co.

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Chairman: **Howard Lovejoy**, vice-president, Puget Sound Freight Lines.

Vice-Chairman: **Alfred P. Nelsen**, manager, automotive parts division, Seattle branch, Wagner Electric Corp.; treasurer: **C. Edwin Johnston**, head, automotive trades department, Edison Technical School; secretary: **Allan D. McLean**, liaison engineer, Kenworth Motor Truck Corp.

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Vice-Chairman: **C. A. Dillinger**, owner, manager, Tokheim Pump Agency; vice-chairman, Aviation: **Fred W. Sparks**, president, Sparks-Wills, Inc.; vice-chairman, Diesel Engines: **William S. Thurlow**, lube and fuel engineer, Standard Oil Co. of Calif.; vice-chairman, Fuels & Lubricants: **William E. Nunnenkamp**, industrial salesman, Texas Co.; vice-chairman, Students: **Prof. W. H. Paul**, mechanical engineering department, Oregon State College; vice-chairman, Tractors: **J. M. Meany**, manager, logging division, Loggers & Contractors Machinery Co.; vice-chairman, Transportation & Maintenance: **Julius Gaussoin**, president, Silver Eagle Co.; vice-chairman, Truck & Bus: **Joseph J. Lovretich**, superintendent of shops, Portland Consolidated Freightways, Inc.; treasurer: **Howard J. Richards**, engineer, draftsman, Consolidated Freightways, Inc.; secretary: **Clarence Bear**, fleet superintendent of maintenance, Hudson-Duncan & Co.

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Chairman: **Linn Edsall**, general superintendent, transportation division, Philadelphia Electric Co.

Vice-chairman: **Robert W. Donahue**, research engineer, Sun Oil Co.; vice-chairman, Aircraft: **Earle Stewart**, staff engineer, Piasecki Helicopter Corp.; vice-chairman, Fuels & Lubricants: **Albert S. Orr**, general foreman, refinery technology division, Gulf Oil Corp.; vice-chairman, Transportation & Maintenance: **Herman G. Steigerwalt**, automotive transportation manager, Suppllee-Wills-Jones Milk Co.; vice-chairman, Truck & Bus: **Harry Bernard**, chief engineer, Mack Mfg. Corp.; treasurer: **Earl Y. Slaughter**, special representative, Studebaker Corp.; secretary: **A. Milton Miley**, application engineer, Electric Storage Battery Co.

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Chairman: **Warren J. Iliff**, superintendent, maintenance, Equitable Auto Co.

Vice-Chairman: **W. J. Kittredge, Jr.**, fleet sales representative, GMC Truck & Coach Division; vice-chairman, Oil City: **Charles R. Scott**, lubrication engineer, Wolf's Head Oil Refining Co., Inc.; treasurer: **Robert R. Chrisman**, lubrication engineer, American Oil Co.; secretary: **Kenneth G. Scantling**, automotive engineer, Equitable Auto Co.

St. Louis

Chairman: **August H. Blattner**, assistant chief draftsman, Carter Carburetor Corp.

Vice-Chairman: **Niels C. Beck**, dean, Parks College of Aeronautical Technology; vice-chairman, Aircraft: **Donald W. Irwin**, hydraulics group engineer, McDonnell Aircraft Corp.; vice-chairman, Diesel Engines: **John A. Wich**, engineer, Busch-Sulzer Brothers Diesel Engine Co., division, Nordberg Mfg. Co.; vice-chairman, Fuels & Lubricants: **Moncrief O. Jefferson**, engine builders representative (Lubrite & White Eagle Divisions) Socony-Vacuum Oil Co., Inc.; vice-chairman, Students: **Eugene S. Kropf**, assistant to dean, Parks College of Aeronautical Technology; vice-chairman, Transportation & Maintenance: **Orval J. Lindell**, superintendent of maintenance, Consolidated Forwarding Co., Inc.; treasurer: **Archie K. Miller**, sales engineer, staff marketing, Socony-Vacuum Oil Co., Inc.; secretary: **Monroe C. Alves**, superintendent of motor transportation, Union Electric Co. of Missouri.

San Diego

Chairman: **F. Herbert Sharp**, assistant project engineer, Consolidated Vultee Aircraft Corp.

Vice-Chairman: **Robert E. Day**, project engineer, afterburner projects, Solar Aircraft Co.; treasurer: **Charles F. Derbyshire**, design and test engineer, Rohr Aircraft Corp.; secretary: **Joseph S. Skurky**, engineering design checker, Solar Aircraft Co.

Southern California

Chairman: **Ben T. Anderson**, executive supervisor of research, Union Oil Co. of Calif.

Vice-Chairman: **Alexander T. Bur-**

n, vice-president, North American ation, Inc.; vice-chairman, Aero- utics: **John B. Wassall**, chief proj- t engineer, Lockheed Aircraft Corp.; e-chairman, Diesel Engines: **John Chiabotti**, sales engineer, Cum- ins Service & Sales; vice-chairman, uels & Lubricants: **Max Epps**, chief utomotive engineer, General Petro- um Corp.; vice-chairman, Passen- er Car; **Charles R. Thomson**, super- ntendent of production, Ford Motor o.; vice-chairman, Production: **John B. Rauen**, president, U. S. Spring & Bumper Co.; vice-chairman, Trans- portation & Maintenance: **A. Martin**, superintendent of maintenance, Pacific Freight Lines; vice-chairman, Truck & Bus: **John B. Clark**; treasurer: **Cecil E. Ellis**, superintendent of maintenance, Southern California Edison Co.; secretary: **Paul L. Garver**, associate public utilities engineer, department of public utilities and transportation, City of Los Angeles.

Southern New England

Chairman: **C. Owen Broders**, designer, Pratt & Whitney Aircraft, division of United Aircraft Corp.

Vice-Chairman: **Hans Hogeman**, chief engineer, fuel injection department, American Bosch Corp.; vice-chairman, Aeronautics: **L. Morgan Porter**, design project engineer, Pratt & Whitney Aircraft; vice-chairman, Bridgeport: **Edward Nesbitt**, sales engineer, Sikorsky Aircraft Division, United Aircraft Corp.; vice-chairman, New Haven: **Fred E. Stockwell**, industrial lubrication engineer, Esso Standard Oil Co.; vice-chairman, Springfield: **C. Harry Nystrom**, section engineer, American Bosch Corp.; treasurer: **Henry J. Fischbeck**, supervisor, metallurgical and chemical processing, Pratt & Whitney Aircraft; secretary: **Robert E. Johansson**, designer, Pratt & Whitney Aircraft.

Spokane-Intermountain

Chairman: **Ernest J. Eldenburg**, partner, Washington Auto-Carriage Works.

Vice-Chairman: **Dwight F. Hume**, manager, truck division, Ernie Majer, Inc.; treasurer: **Harold C. Besgrove**, automobile and truck maintenance supervisor, Washington Water Power Co.; secretary: **Donald E. Majer**, vice-president, treasurer, Ernie Majer, Inc.

Syracuse

Chairman: **Carl F. B. Roth**, president, general manager, director, Air-cooled Motors, Inc.

Vice-Chairman: **Claude M. Bigelow**, purchasing agent, Brockway Motor, Co., Inc.; vice-chairman, Elmira: **J. F. Murphy**, development engineer, Eclipse Machine Division, Bendix Aviation Corp.; vice-chairman, Sidney: **Henry T. Wright**, senior test engineer, Scintilla Magneto Division, Bendix Aviation Corp.; treasurer: **David T. Doman**, project engineer (special assignment), Porter-Cable Machine Co.; secretary: **Robert S. Root**, assistant chief engineer, clutch division, Lipe-Rollway Corp.

Texas

Chairman: **Horrell Gus Erickson**, chief engineer, Texas Engineering & Mfg. Co.

Vice-Chairman: **Richard W. Hoyt**, vice-president, chief engineer, Double Seal Ring Co.; vice-chairman, Houston; **E. J. Strawn**, regional automotive supervisor, Shell Oil Co.; treasurer: **Tom J. Collins**, general manager, Holland Page Industries; secretary: **Frank V. Esden**, district manager, Cedar Rapids Engine Co.

Twin City

Chairman: **Wayne E. Schober**, chief engineer, Viking Tool & Die Co.

Vice-Chairman: **S. Reed Hedges**, automotive engineer, Minneapolis-Moline Co.; treasurer: **Prof. Emeritus Burton J. Robertson**, University of Minnesota; secretary: **Prof. Newman A. Hall**, thermodynamics, Engineering Experiment Station, University of Minnesota.

Virginia

Chairman: **F. M. Hutcheson**, general sales manager, Motor Parts Corp.

Vice-Chairman: **Albert G. Griffin**, salesman, Benjamin T. Crump Co.; treasurer: **Percy J. Carr**, president, Carr-Woodall Tire Service, Inc.; secretary: **Harold N. Tyler, Jr.**, vice-president, Tyler Oil & Chemical Corp.

Washington

Chairman: **Bertram Ansell**, partner, Ansell & Goda.

Vice-Chairman: **John B. Hulse**, secretary, manager, Truck-Trailer Manufacturers Association, Inc.; vice-chairman, Aircraft: **Thomas T. Neill**, assistant to director of research, National Advisory Committee for Aeronautics; vice-chairman, Engineering Materials: **Allen P. Blade**, chief, motor equipment section, office of business operations, U. S. Atomic Energy Commission; vice-chairman, Transportation & Maintenance: **Lt.-Col. William A. McCutcheon**, administrative managing analyst for motor equipment, Executive Office of the President, Bureau of the Budget; treasurer: **Douglas K. Bonn**, special representative, Government department, U. S. Rubber Co.; secretary: **Thomas W. Bishton**, assistant superintendent, city refuse division, District of Columbia Government.

Western Michigan

Chairman: **Maurice W. Bolster**, district industrial salesman, Shell Oil Co., Inc.

Vice-Chairman: **George E. Dake, Jr.**, engineer, FitzJohn Coach Co.; treasurer: **William H. Kennedy**, diesel engineer, Continental Motor Corp.; secretary: **Gaylord E. Smith**, project engineer, Muskegon Piston Ring Co.

Wichita

Chairman: **Virgil W. Hackett**, chief draftsman, Cessna Aircraft Co.

Vice-Chairman: **Gomer W. Jones**, design engineer, Beech Aircraft Corp.; treasurer: **Donald C. Simon**, hydraulics engineer, Cessna Aircraft Co.; secretary: **Harold G. Dick**, operating manager, Spines Clothing Co.

GROUPS

Atlanta

Chairman: **Charles F. Whitmer**, assistant to supervisor of automotive equipment, Georgia Power Co.

Vice-Chairman: **Karl H. Nonweiler**, division lubricants manager, Shell Oil Co., Inc.; treasurer: **Zack T. Layfield, Jr.**, Layfield's Garage, Inc.; secretary: **Jack S. Reid**, director of service, De Soto-Plymouth Dealer, Wagstaff Motor Co., Inc.

Colorado

Chairman: **Kenneth G. Custer**, assistant technical director, Gates Rubber Co.

Vice-Chairman: **Francis E. Raglin**, assistant transportation engineer, Public Service Co. of Colorado; treasurer: **Norman B. Spitzer**, field engineer, Spitzer Electrical Co.; secretary: **Prof. Robert F. Brown**, mechanical enginering department, University of Colorado.

Mohawk-Hudson

Chairman: **Martin J. Berlyn**, consulting engineer, American Locomotive Co.

Vice-Chairman: **Charles W. Wyld**, district manager, Autocar Sales & Service Co., Inc.; secretary-treasurer: **John Fitz Hill**, instructor, Rensselaer Polytechnic Institute.

Salt Lake

Chairman: **Stanley W. Stephens**, shop foreman, service engineer, Koepsel & Love.

Vice-Chairman: **Dean Despain**, garage superintendent, Holsum Bread Co.; secretary-treasurer: **Richard Ostlund**, chief engineer, trailer division, Lufkin Foundry & Machine Co.

Williamsport

Chairman: **D. S. King**, assistant chief engineer, Lycoming-Spencer Division, Avco Mfg. Corp.

Vice-Chairman: **Adam E. Sieminski**, chief draftsman, Lycoming Division; treasurer: **Fredric G. Rohm**, chief experimental engineer, Lycoming-Spencer Division; secretary: **Horace W. Epler**, assistant chief draftsman, Lycoming-Spencer Division.

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of these cars reminded many present of the practicability which we have sacrificed for styling in our modern automobiles.

Beautiful weather prevailed throughout the day enabling many members and guests to display their prowess on the golf course.

Motor Boat Fans Hear Expert Speak

• Western Michigan Section
L. W. Kibbey, Field Editor

May 13—Western Michigan ended a season which set records for attendance and interest with a sportsman's night at which 142 members and guests ate a delicious fried perch dinner and then heard a comprehensive and detailed report on development, design, and operation of outboard motors.

Speaker was **W. C. Conover,** chief engineer of Outboard Marine & Mfg. Co., who brought along an expertly done cutaway of the new Johnson 25 hp 2-cyl motor that was the main subject of his talk. He also brought along a 16-mm color-sound film of pictures taken at various outboard motor racing events. These illustrated graphically the tremendous ruggedness and stamina designed and built into these motors to meet the gruelling conditions under which they must operate.

Conover answered numerous questions by the many boat owners present, all of whom were just about getting their motors out and putting them into condition for the Western Michigan fishing and boating season.

Describes Varieties Of Surface Finish

• Cincinnati Section
Walter Walkenhorst, Jr., Field Editor

May 28—The tool engineer would have very little difficulty, through visual inspection of a machined metallic surface, deducing the method used in finishing it. So said **Douglas T. Peden,** chief research engineer for Micromatic Hone Corp., speaking before 80 members and guests of this Section. This is so because all metal-removing processes leave "finger-prints" in the form of characteristics showing the direction and type of cutting action and the severity of the force used.

The three commonly used methods of generating surface finishes—cutting and turning; abrading and grinding; and honing and lapping—were discussed in that order. The paper was supplemented by a very interesting film showing the effect each generating method has on different types of material.

A vigorous question period was followed by a social hour.

Loyola University

V. E. Peterson, past-chairman of the American Society of Mechanical Engineers, was on hand at Loyola's May 23 Student Branch meeting to talk to members about their responsibilities to themselves, their profession, and their country. The meeting, at which new officers were installed, also got praise for its past work and encouragement for its future activities from J. W. Sinclair, Southern California Section student vice-chairman.

Students Enter Industry

Continued from Page 82

at Illinois, and is now a research engineer with Shell Oil Co. at Martinez, Calif.

WILLIAM V. CHAMBERS (Bradley University '50) is with General Electric Co., Schenectady, N. Y.

LUCILLE JOYCE PIETI (Wayne University '50) is on the editorial staff of Ward's Automotive Reports in Detroit.

DONALD T. CHASE (Michigan State College '50) is at B. F. Goodrich Co., Akron, Ohio.

DON J. CRITTON (University of Michigan '50) is now a tool engineer for West Bend Aluminum Co., Hartford, Wisc.

ROBERT D. HAYWARD (University of Colorado '50) is with B. K. Sweeney Mfg. Co., Denver, Colo.

HAROLD AZAREN (University of Illinois '50) is with B & M Engineering Co., Burbank, Calif.

JOHN H. SALOMON (Yale University '50) has joined United Illuminating Co., New Haven, Conn.

JOHN H. ROBSON, JR. (Wayne University '50) is a statistician with Ford Motor Co.

WILLIAM RALPH RIMBEY (University of Illinois '50) is with Dodge Mfg. Corp., Mishawaka, Ind., as a development engineer.

JOHN MICHAEL RITCHIE (University of Massachusetts '50) is with National Carbon Division, Union Carbide & Carbon Corp.

WILLIAM ALFRED PRICE (Purdue University '50) is now co-owner of Price Garage in South Bend, Ind.

RALPH J. RAYS (General Motors Institute '51) is with GMC Detroit Diesel Engine Division.

GORDON WANG (Michigan State College '51) has joined American Marsh Pumps Co., Battle Creek, Mich.

JAMES D. CARMICHAEL (Rensselaer Polytechnic Institute '51) is in the products application department of Texas Company's laboratories at Beacon, N. Y.

FREDERICK G. BAILY (California Institute of Technology '51) is now a test engineer with General Electric Co., Schenectady, N. Y.

RAMON VIDRI (McGill University '51) is with Vidri Panades and Co., San Salvador, El Salvador, Central America.

BRUCE DEYO (Michigan State College '51) is with the Navy Department's Bureau of Ships, Washington, D. C.

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Students Enter Industry

Continued

GUY BERTRAND (McGill University '51) is now with G.A.R.D.E., Valcartier, Quebec.

FRANK E. FIELD (Lawrence Institute of Technology '51) is a customer engineer with International Business Machines Corp. in Detroit.

GERARD HACKETT (McGill University '51) is with Otis Elevator Co., Ltd., Hamilton, Ont., Canada.

JAMES A. CORSON (Lehigh University '51) is with Westinghouse Electric Corp., Aviation Gas Turbine Division, Lester, Pa., as application engineer.

EDWARD COZZARIN (Lawrence Institute of Technology '51) is with Detroit engine division of Kaiser-Frazer.

CHARLES BALCHUNAS (Rensselaer Polytechnic Institute '51) is with the test engineering program of General Electric Co., Lynn, Mass.

JOHN McNEILL (McGill University '51) is with Dominion Steel & Structure Co., Ltd., Montreal.

ROBERT C. CROWE (Pennsylvania State College '51) is now with Piasecki Helicopter Corp., Morton, Pa.

FRANK W. LIVINGSTON (Northrop Aeronautical Institute '51) is a junior process engineer with GMC Buick-Oldsmobile-Pontiac Assembly Division, Kansas City, Kans.

GERHARD TEICHROEB (University of British Columbia '51) is with Valley Equipment Co., Chilliwack, B. C., Canada.

T. J. DUNCAN (University of Colorado '51) is now with U. S. Gypsum Co. at Fort Dodge, Iowa.

ARTHUR J. KAHKEJIAN (Rensselaer Polytechnic Institute '51) is with General Electric Co., West Lynn, Mass.

EUGENE B. CANBY (Queens University '51) is now with Atlas Steel Co., Wainfleet, Ontario, Canada.

BRUCE WINANS SMITH (Michigan State College '50) is now dynamometer engineer with Reo Motors, Inc., Lansing, Mich.

JOSEPH F. SBARRA (Indiana Technical College '50) is at Continental Aviation & Engineering Corp., Detroit.

JOSEPH M. LATONIS (Tri-State College '50) is now with McDonnell Aircraft Corp., St. Louis, Mo.

JAMES E. ROBINSON (Ohio State University '50) is with Seagrave Corp., Columbus, Ohio.

ROBERT L. FRANZEN (University of Colorado '50) is now with the Air Force at Patrick Base, Cocoa, Fla.

WILLIAM E. SINDELAR, JR. (Illinois Institute of Technology '51) is with American Steel Foundries, Chicago, as project engineer trainee.

MORTON S. FEINSILVER (New York University '51) is a junior engineer with Wright Aeronautical Corp., Wood-Ridge, N. J.

ARTHUR A. CHRISTOPHER (Indiana Technical College '50) is a draftsman with the coal division of United States Steel Co., Uniontown, Pa.

HENRY C. DeWALL (Indiana Technical College '50) is a design engineer with the U. S. Naval Torpedo Station at Newport, R. I.

BOBBY G. DUDLEY (Parks College '50) is at present a U. S. Civil Service instructor at Sheppard Air Force Base, Texas.

PAUL B. HAYES (Northrop Aeronautical Institute '50) is with North American Aviation Co., Inglewood, Calif., as a stress analyst.

WARREN R. SALZMAN (Purdue University '50) is at the Springfield, Ill., works of Allis-Chalmers Mfg. Co.

CLARENCE W. JOHNSON (Tri-State College '49) is with Climax Molybdenum Co. of Michigan.

LELAND D. CHAMNESS (Northrop Aeronautical Institute '50) is a draftsman with Aircraft Engineering & Maintenance Co., Oakland, Calif.

RAYMOND C. BEVAN (Tri-State College '51) is now with Diamond Alkali Co., Painesville, Ohio.

PIERCE E. GLEFKE (General Motors Institute '51) is now district representative for Saginaw Welding Supply Co., Saginaw, Mich.

WALTER F. McCOSKEY (Lawrence Institute of Technology '51) is with the tank division of Ford Motor Co.

EDWARD HAMPARIAN (Lawrence Institute of Technology '51) is design engineer with the Detroit Tank Arsenal, Center Line, Mich.

KENNETH RAY HEISER (Indiana Technical College '51) is with John Deere Harvester Works, East Moline, Ill.

GLENN H. LEWIS (University of Colorado '50) is at Wright-Patterson Air Force Base, Dayton, Ohio.

WALTER J. OLIVER (University of Illinois '50) is in the Army at Fort Belvoir, Va., where he is a writer in the department of training publications.

RICHARD V. RUBLY (University of Colorado '50) is a development engineer with Aerojet Engineering Corp., Azusa, Calif.

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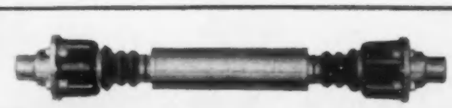
Improvements pioneered by Universal Products during 38 years of concentration on one product are a major reason why universal joints give owners less service trouble than almost any other moving automotive part.



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Students Enter Industry

Continued

HERBERT K. T. CHOY (Tri-State College '49) has completed further study at Tri-State and is now with the plant and structure division of the Civil Aeronautics Administration, Honolulu, T. H.

J. W. PRISER (Parks College '50) is with Glenn L. Martin Co., Baltimore.

DONALD L. REICHELT (University of Wisconsin '50) is a pilot with the Army Air Force. Lieutenant Reichelt is stationed at Craig Base, Selma, Ala.

STANLEY W. COUSLEY, JR. (Yale University '51) is in the research department of Atlantic Refining Co., Philadelphia, Pa.

RICHARD G. ZAHNER (Pennsylvania State College '51) is with the test engineering program of General Electric Co. in Lockland, Ohio.

O. H. STELTER, JR. (University c Colorado '50) is in Houston, Texa with Stewart & Stevenson Services, In

ROBERT L. NANCE (Purdue University '50) is a junior engineer in th testing laboratory of GMC Cadilla Motor Car Division, Detroit.

KENNETH SECUNDA (Wayne University '50) is with Detroit Steel Products Co., spring division.

ROBERT T. GAUGER (Purdue University '50) is now with Waukesha Motor Co., Waukesha, Wisc.

F. W. SHEPHERD (University of Minnesota '50) is head of the mechanics section of the test development branch, U. S. Naval Proving Ground, Dahlgren, Va.

RICHARD A. STURLEY (Yale University '50) is with Carrier Corp., Syracuse, N. Y.

ROY D. STRADER (Aeronautical University '50) is with Bendix Products Division, South Bend, Ind., as stress engineer in the shock strut department.

JACK KESTER WILLIS (California Institute of Technology '50) is with Douglas Aircraft Co., Inc., Santa Monica, Calif.

JOSEPH F. KING (San Diego State College '51) is now employed in the U. S. Navy Electronics Laboratory, San Diego, Calif.

QUENTEN A. RIEPE, (University of Minnesota '51) is in the Air Force at Wright-Patterson Base, Dayton, Ohio. Major Riepe is with the Office of Air Research.

RAYMOND L. OWENS (Rensselaer Polytechnic Institute '51) is with Linde Air Products Co., Tonawanda, N. Y.

ROBERT E. STONG (Purdue University '51) is an engineering sales trainee with Caterpillar Tractor Co., Peoria, Ill.

LOU CIARROCCA (San Diego State College '51) is employed by General Electric Co., gas turbine division, but is at present on military leave of absence to the Navy.

RODNEY ALLAN HIDDE (San Diego State College '51) is a junior structural engineer with Consolidated Vultee Aircraft Corp., San Diego, Calif.

H. DANA MORAN (Northrop Aeronautical Institute '51) is now with Northrop Aircraft, Inc., as a basic loads analyst.

CHARLES EDWARD AXTHELM (Ohio State University '51) is an ensign aboard the U.S.S. Essex.

RICHARD J. VICKERS (Northrop Aeronautical Institute '51) is with Northrop at Hawthorne, Calif.

Students Enter Industry

Continued

JAMES H. MARSHALL (Oklahoma A & M '51) is with the Shell Oil Co. in Tulsa, Okla.

HUGH COLEOPY (University of British Columbia '51) is with Vivian Diesels & Munitions, Ltd., Vancouver, B. C., Canada.

BENJAMIN L. SHEAFFER (Purdue University '51) is a 2nd lieutenant in the U. S. Marine Corps.

RICHARD M. SHERWOOD (Purdue University '51) is with Wright Aeronautical Corp., Wood-Ridge, N. J.

AIMO J. PITKANEN (Parks College '51) is with A. V. Roe Canada, Ltd., Malton, Ontario.

DONALD J. LONG (Oklahoma A & M '51) is at the Wichita division of Boeing Airplane Co., Wichita, Kans.

ERNEST A. KUSSMAUL (Academy of Aeronautics '50) is with Stratos Division, Fairchild Engine & Airplane Corp., Farmingdale, N. Y., but is at present on military leave of absence to the Army. He is stationed at the Ordnance School, Aberdeen Proving Ground, Md.

ROBERT W. WESSELN (University of Illinois '50) is with hydraulic division, Sunstrand Machine Tool Co., Rockford, Ill.

WILLIAM CRAM MORGAN (Virginia Polytechnic Institute '50) is in the research laboratory of GMC Detroit Diesel Engine Division.

JAMES L. PHIPPS (San Diego State College '51) is with Consolidated Vultee Aircraft Corp., San Diego, Calif.

FRANK J. JOHN (Rensselaer Polytechnic Institute '51) is with the Army Ordnance Department at Watervliet Arsenal, Watervliet, N. Y.

GROVER C. MELLIN, JR. (Purdue University '51) is a senior draftsman with Cummins Engine Co., Columbus, Ind.

WILLIAM FREDERICK HARRISON (Purdue University '51) is a job methods engineer with RBM Division, Essex Wire Corp., Logansport, Ind.

EDWARD B. COOK (Oklahoma A & M '51) is now with Halliburton Oil Well Cementing Co. in Duncan, Texas.

RICHARD BURTON CURRY (Purdue University '51) is with Corn Products Refining Co., Argo, Ill.

RICHARD P. DINGLER (Purdue University '51) is in the engineering test department of GMC Frigidaire Division, Dayton, Ohio.

GORDON J. MASON (University of Colorado '51) is with Caterpillar Tractor Co., Peoria, Ill.

ANDREW W. BIAS (Northrop Aeronautical Institute) is now a draftsman with North American Aviation, Inc., at Downey, Calif.

K. GILBERT SODER (Purdue University) is a laboratory technician with GMC Allison Division, Speedway, Ind.

DAVID R. ENGLUND, JR. (Yale University '51) is with the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics, Cleveland, Ohio.

DOUGLAS M. BIRKS (Northrop Aeronautical Institute) is a wind tunnel operator in the research laboratory of California Institute of Technology.

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Students Enter Industry

Continued

ROBERT B. BENJAMIN (University of Illinois '51) is a civilian employee at Design & Development Command, Wright-Patterson Air Force Base, Dayton, Ohio.

WILBURT OLSHANSKY (Lawrence Institute of Technology) is now a draftsman with Leahy Electric Co.

WILBUR E. BASSETT (University of Massachusetts '51) is a test engineer with General Electric Co., at Pittsfield, Mass.

EDWARD H. KUSIAK (University of Massachusetts '51) is with the research division of Springfield Armory, Springfield, Mass.

RICHARD R. BURLEY (Valparaiso University '51) is now in Cleveland with the National Advisory Committee for Aeronautics.

LEO SANFORD PARRY (Wayne University '50) is now with Harry Ferguson, Inc., Detroit.

GERALD W. DALDER (Wayne University '50) is also with GMC Detroit Diesel Engine Division as specifications writer in the parts department.

ROBERT M. CARLSON (University of Minnesota '50) is with GMC research laboratories division in Detroit.

GEORGE D. GRUENWALD (Cal-Aero Technical Institute '50) is at North American Aviation, Inc., Downey, Calif.

FRANK HENRY ABAR, JR., (Wayne University '50) is a road test engineer with Chrysler Corp. in Highland Park, Mich.

KENNETH J. PRCHAL (Aeronautical University '50) is a senior engineering draftsman with Glenn L. Martin Co., Baltimore, Md.

JAMES R. WARTERS (Aeronautical University '51) is now with Goodyear Aircraft Corp., Akron, Ohio.

LLOYD J. VERKET (State University of Iowa '51) is at the U. S. A. F. Ogden Air Materiel Area, Hill Field, Utah.

JAMES R. WOODWARD (San Diego State College '51) is a research technician with Solar Aircraft Co., San Diego, Calif.

FRANK L. BUSCARELLO (University of Michigan '51) is with Continental Aviation & Engineering Corp., Detroit.

DONALD C. SCOVILLE (University of Michigan '51) is now with GMC research laboratories division, Detroit.

RICHARD L. PASCOE (Aeronautical University '51) is a chief pilot at Chicago Seaplane Base, Chicago, Ill.

FREDERICK P. KRIPPAEHNE (University of Washington '51) is with Boeing Airplane Co., Seattle, Wash.

FRANCIS R. TITCOMB (University of of Maine '51) is at Radio Corp. of America, Lancaster, Pa.

EDWIN J. PIERSMA (University of Michigan '51) is now with General Motors Technical Center, Detroit.

JAMES G. PAULY (University of Michigan '51) is with Fram Corp., Dexter, Mich.

WILBUR G. PAULSON, JR. (University of Wisconsin '51) is now with Boeing Airplane Co., Seattle, Wash.

HERBERT STANELAND (University of Toronto '51) is with Massey-Harris Co., Ltd., Toronto.

Continued on Page 106

Students Enter Industry

Continued

OMER W. NICHOLS (University of Pittsburgh '51) is with the graduate student training program of Westinghouse Electric Corp., East Pittsburgh, Pa.

ROBERT M. McKAY (Wayne University '51) is also with General Electric Co., in Schenectedy.

BERNARD ARTHUR SPON (University of Pittsburgh '51) is assistant project engineer at U. S. Air Research & Development Corp., Dayton, Ohio.

EARL R. LOHNEIS (University of Wisconsin '51) is a senior draftsman with Kearney & Trecker Corp., West Allis, Wisc.

JOHN FRANK TAKERER (University of Pittsburgh '51) is with the test program of General Electric Co., Schenectedy, N. Y.

CHARLES E. NEELLEY (A & M College of Texas) is experimental liaison engineer at Chance Vought Aircraft Co. in Grand Prairie, Texas.

ROSS W. LAMB (Aeronautical University '51) is with Bell Aircraft Corp. at Niagara Falls, N. Y.

VINCENT A. MELI (University of Florida '51) is at Wright-Patterson Air Force Base, Dayton, Ohio. Sergeant Meli is with the vibrations unit, powerplant laboratory.

JAMES A. SIEVERT (University of Wisconsin '51) is with Marathon Corp., Menasha, Wisc.

V. HUGO SCHMIDT (Washington State College '51) is now with the Air Force at Wright-Patterson Base, Dayton, Ohio, in the Air Research & Development Command.

JACK W. HAWKINS (Wayne University '51) is now with Halley Carburetor Co., Detroit.

GEORGE B. JOSTEN (University of Illinois '50) is in the layout and methods section of Canton Forge Division, Ford Motor Co., Canton, Ohio.

HAROLD L. PETERSON (University of Washington '50) is now in service with the U. S. Marines.

JOHN MOCKOVCIAK, JR., (New York University '51) is a draftsman on experimental designs with Grumman Aircraft Engineering Co., Bethpage, N. Y.

JOSEPH E. CHRISTIANO (Academy of Aeronautics '51) is an aircraft inspector for Glenn L. Martin Co., Baltimore.

BOLESLAUS F. PRZYBYCIN (Illinois Institute of Technology '51) is now with Western Electric Mfg. Co. in Chicago.

CHARLES V. TONER (Villanova College '51) is now with the Piasecki Helicopter Co., Morton, Pa.

CHARLES MAUCH (University of Detroit '51) is with the tank division of Ford Motor Co., Highland Park, Mich.

GORDON C. OLSON (University of Wisconsin '51) is now at Boeing Airplane Co., Seattle, Wash.

R. J. PACKARD (University of Wisconsin '51) is a process engineer at Teletype Corp., Chicago.

CHARLES E. SUCHMA (University of Pittsburgh '51) is now with GMC Delco Products Division, Dayton, Ohio.

WILLIAM J. GREENWALD (Purdue University '51) is now manager-trainee for Kingan & Co., Indianapolis, Ind.

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CENTRIFUSE BRAKE DRUMS

Students Enter Industry

Continued

EDWARD F. MERSEREAU (Newark College of Engineering '51) is a 2nd lieutenant with the Air Research and Development Command at Wright-Patterson Base, Dayton, Ohio.

LEIGH K. LYDECKER, JR. (Stevens Institute of Technology '51) is with Babcock & Wilcox Co. of New York.

KENNETH W. JONES (University of British Columbia '51) is an aircraft design engineer with A. V. Roe Canada, Ltd., Malton, Ontario.

WAYNE L. HINTHORN (University of Colorado '51) is at Pullman-Standard Car Mfg. Co., in the research and development department.

FLORINE K. BENDER (Purdue University '51) is with the research and development department of Pullman-Standard Car Mfg. Co., Hammond, Ind.

JOHN A. MOWBRAY (Rensselaer Polytechnic Institute '51) is a designer for Sperry Gyroscope Co., Great Neck, N. Y.

BILL HEIDEL (Bradley University '51) is at Rock Island Arsenal, Rock Island, Ill.

MARCUS M. SCHNAUBELT (Carnegie Institute of Technology '51) is a graduate student trainee at Westinghouse Electric Corp., East Pittsburgh, Pa.

JOSEPH R. FAITEL (Cal-Aero Technical Institute '50) is an engineering aide with Domanco Co., Inc., Torrance, Calif.

ARTHUR E. BURKE, JR. (Indiana Technical College '50) is at the U. S. Naval Torpedo Station at Newport, R. I., in the propulsion division.

GUY C. CISCO, JR. (Parks College '50) is a student officer in pilot training at James Connally Air Force Base, Waco, Texas.

STANLEY P. FUNKHOUSER (Indiana Technical College '50) is with Aro Equipment Corp., Bryan, Ohio.

FRANK E. PILLING, JR. (California State Polytechnic College '50) is vice-president in charge of production of Century Gas Equipment Co., Lynnwood, Calif.

FRANK S. URBANEK (Rensselaer Polytechnic Institute '50) is now with the electro-mechanical development section of General Electric Co., Schenectedy, N. Y. He was formerly at the company's plant at Pittsfield, Mass.

GEORGE D. DEVEAUX (Northrop Aeronautical Institute '50) has joined Northrop Aircraft, Inc., Hawthorne, Calif.

WILSON D. COOPER (University of Wichita '50) is field sales manager in Kansas City, Mo., for Ford Motor Co. Lincoln-Mercury Division.

GARY GREY SINTON (Aeronautical University '50) is a junior aerodynamic engineer with Glenn L. Martin Co., Baltimore, Md.

HOWARD P. FREERS (Rose Polytechnic Institute '48) has completed his graduate work at Chrysler Institute and joined the engineering division of Chrysler Corp.

PERRY SWARTZ (Wayne University '50) is a methods and time study engineer with GMC Diesel Division in Detroit.

WILLIAM DODGE WENTZ (Ohio State University '49) is a safety engineer with American Associated Insurance Companies in Atlanta, Ga.

Students Enter Industry

Continued

AMES McGOWN, JR. (McGill University '51) is with Canadian Pacific Railway Co., Vancouver, B. C., Canada.

EORGE H. DICKERT (Lafayette College '51) is now with Standard Oil Co. (N. J.), Linden, N. J.

HOWARD L. WEBER (Lawrence Institute of Technology '51) is with GMC process development section, Detroit, as development engineer.

JAN MURER (McGill University '51) is now with Aluminum Laboratories, Ltd., Montreal, Quebec, Canada.

CHARLES O. YOUNG (Indiana Technical College '51) has joined Indiana State Highway Department, Ft. Wayne, Ind.

ARTHUR F. DEWSBERRY (Northwestern University '51) is with International Harvester Co., Melrose Park, Ill., with which he has been associated since 1948.

JAMES CLARK SHOFFNER (Ohio State University '51) is with Minneapolis-Honeywell Regulator Co., Philadelphia.

HAROLD SILVER (University of Oklahoma '51) is working in Stevens Institute powder metallurgy laboratory, Hoboken, N. J., while doing graduate study at the institute.

JOHN J. PIETRUSZKIEWICZ (Academy of Aeronautics '51) has since last fall been with Leviton Mfg. Corp., Brooklyn, N. Y.

FREDERICK WILLIAM BEYER, JR. (Bradley University '51) has joined Caterpillar Tractor Co., Peoria, Ill.

ALAN T. RIES (California State Polytechnic College '51) is now with Northrop Aircraft, Inc., Hawthorne, Calif.

THOMAS HALL ATKINSON (Bradley University '51) is a weight engineer with Boeing Airplane Co., Seattle, Wash.

ROY H. SPAULDING (Tri-State College '50) is now with Aro Equipment Corp., Bryan, Ohio.

E. ROBERT POWERS (Carnegie Institute of Technology '51) is with the Naval Air Material Center, Philadelphia.

RUDOLPH J. MENART (Fenn College '51) has joined Sabin Machine Co., Cleveland, Ohio.

LEONARD H. KRAMER (College of the City of New York '51) is now at New York Naval Shipyard, Brooklyn, N. Y.

THOMAS T. BEAZLEY (A & M College of Texas '51) is with Sperry Gyroscope Co., Great Neck, N. Y.

CARL S. NAU (Fenn College '51) is with Westinghouse Electric Corporation's graduate student training program.

CHARLES J. WEBER (Purdue University '50) is now acting assistant quality control supervisor at Kaiser-Frazer Detroit Engine Division.

JULIAN H. PFANNMULLER (Academy of Aeronautics '51) has joined Goodyear Aircraft Corp., Akron, Ohio.

B. J. LUDWIG (Chrysler Institute '51) is now with Chrysler Corp. at the proving ground at Chelsea, Mich.

WILLIAM S. THOMPSON, JR. (University of Oklahoma '51) is an Air Force pilot stationed at Will Rogers Field, Oklahoma City, Okla.

Continued on Page 110

Students Enter Industry

Continued

ERNEST A. MAIER (University of Wisconsin '51) has been recalled to active duty with the USNR at Camp Pendleton, Calif.

ROBERT L. HAUSER (General Motors Institute) is now with the Army engineers at Fort Belvoir, Va.

HAROLD E. BEEGLE (Pennsylvania State College) is battalion adjutant of the 756th Transportation Railway Shop Battalion at Fort Eustis, Va.

JOHN JOSEPH DWYER, JR. (Manhattan College) has been called to active duty with the Navy aboard the U.S.S. Achernar.

JUAN ANTONIO VASQUEZ, JR. (Loyola University '51) is now with Creole Oil Co., Caracas, Venezuela.

TAKASHI YAMASHITA (University of Colorado) is serving in the Army at Camp Roberts, Calif.

DONALD A. BIRCH (Aeronautical University) is in the Air Force at Barksdale Base, La. Lieutenant Birch is a bombardier.

RICHARD W. BURGE (U.C.L.A.) is at present with Propulsion Research Corp., Inglewood, Calif.

ROBERT L. KENDIG (Pennsylvania State College) is in the Air Force at Clark Base. Captain Kendig is with the 6200 maintenance squadron.

FREDERICK J. WARRELL (Michigan State College '51) has received his M.S. degree in mechanical engineering and will enter Chrysler Institute for further study.

ROBERT OLAF RINGOEN (Michigan State College '51) has received his M.S. degree and joined Boeing Airplane Co., Seattle, Wash.

PHILIP TUTTLE HEUSTON (University of Colorado '50) is with Gates Rubber Co., Denver.

WILLIAM L. HUBKA (University of Washington '50) is at Texas Co. in Seattle, Wash.

VICTOR J. HURYCH (University of Detroit '50) is a senior tool designer with GMC diesel engine division, Detroit.

JEROME JACOBSON (University of Illinois '50) is with Bureau of Ships, Navy Department, Washington, D. C.

GLEN R. WALTERS (Oregon State College '50) is with Boeing Airplane Co., Seattle, Wash., as junior engineer.

HERBERT N. JOHNSON, JR. (Northrop Aeronautical Institute '48) is a draftsman for North American Avia-

Continued on Page 112

Students Enter Industry

Continued

tion, Inc., while continuing his studies in night courses at University of Southern California.

DONALD RAYMOND SMITH (University of Southern California '50) is a civilian employee of the Air Force at Edwards Base, Muroc, Calif.

FRANCIS J. SHINALY (Pennsylvania State College '49) has almost completed work for his M.S. degree and is employed at Frankford Arsenal, Philadelphia.

CHARLES E. POWERS (University of Cincinnati '50) is with GMC Aeroproducts Division, Dayton, Ohio, as project and design engineer.

HARRY R. PAULSON (University of Southern California '50) is working on rockets at Naval Ordnance Test Station, China Lake, Calif.

JAMES A. OEDER (Oregon State College '50) is with transportation division, General Electric Co., Portland, Ore.

WILLIAM A. MICHAELS (Ohio State University '50) is with the Bryant Heater Division of Affiliated Gas Equipment Corp., Cleveland.

HERBERT GUSTAV MENDE (Wayne University '50) is an engineering analyst with American Blower Corp., Dearborn, Mich.

ALAN C. LODELL (Oregon State College '50) is now at Boeing Airplane Co., Seattle, Wash.

WILLIAM H. LAWRENCE (Purdue University '50) is working on producton control for A. O. Smith Corp., Milwaukee, Wis.

WILLIAM EVAN LITTLE (Purdue University '50) is with GMC's Cadillac Division.

BENJAMIN LANE (University of Southern California '50) has joined General Conveyor, Inc., in Los Angeles.

WILLIAM A. JUDE (University of Colorado '50), employed by Denver Fire Clay Co., is on military leave of absence at Camp Carson, Colo.

JOHN D. CAIRNS (University of Massachusetts '50) is now with General Electric Co. in New Bedford, Mass.

ROBERT McCORMICK (New York University '50) is now in service as an Air Force officer.

ANTHONY N. COTA (Bradley University '50) is associated with Automatic Electric Co., Chicago.

HOWARD ALLEN HILL (San Diego State College '50) is now on active duty with the Navy. He is a submarine as-

Continued on Page 114

Students Enter Industry

Continued

sistance engineering officer somewhere in the Pacific.

A. W. PRICHARD (Tri-State College '50) is assistant development engineer with Union Carbide & Carbon Corp. chemical division in Oak Ridge, Tenn.

PAUL H. MOREHEAD (General Motors Institute '50) is with GMC Buick Motor Division in Flint, Mich.

PAUL E. MINUTH (Detroit Institute of Technology '50), who was with Parke, Davis & Co., has been recalled to active duty. Captain Minuth is with the Air Force.

RAYMOND JOSEPH BOSK (Indiana Technical College '50) is a heat transfer engineer with Griscom-Russell Co., Massillon, Ohio.

PAUL W. TAFEL (Indiana Technical College '50) is with American Machine & Foundry Co., Brooklyn, N. Y., as a draftsman.

JAMES E. VEVERA (Georgia Institute of Technology '50) is now with Wright Aeronautical Corp., Wood-Ridge, N. J.

JOHN ROBERT ANDERSON (University of Washington '49) has completed a year of study at Cornell University and is with Boeing Airplane Co., gas turbine unit, Seattle, Wash.

RUSH SIMONSON (Oklahoma A & M '50) is now with National Carbon Division, Union Carbide & Carbon Corp., in Dallas, Texas.

MARTIN L. TOWNER (Aeronautical University '50) is a flight test engineer with Piasecki Helicopter Corp., Morton, Pa.

LEO ALFRED WACK (Indiana Technical College '50) is with Goodyear Aircraft Corp., Akron, as a senior draftsman.

EDWARD A. BREVICK (Wayne University '50) is in the engineering training program of GMC's Chevrolet Gear & Axle Division.

MARSHALL E. BECKER (Northrop Aeronautical Institute '50) is now at Kellett Aircraft Corp., Camden, N. J., as a draftsman.

DICK L. GREER (Cal-Aero Technical Institute '50) is with Consolidated Vultee Aircraft Corp., San Diego, Calif.

ALVIN GORENBEIN (California State Polytechnic College '50) is assistant technical training supervisor with Bendix Aviation Corp., Burbank, Calif.

HARRY L. GREENE (University of Southern California '50) is at the U. S. Naval Ordnance Test Station at Pasadena, Calif.

New Members Qualified

These applicants qualified for admis- sion to the Society between June 1 1951 and July 10, 1951. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

Joseph P. Bahorich (J).

Buffalo Section

Percy D. Hutton (A).

Canadian Section

George Carson Bradley (M), Stewart Brillinger (A), John Wilson Cook (A), John H. Dunlop (M), Phil Gauvreau (A), Jack Wanless Hasen (A).

Central Illinois Section

H. L. McCormack (M).

Chicago Section

V. C. Barth (M), C. H. Crawford (M), Ernest L. Gregory (M), Harvey B. Gunn (M), R. C. Gunness (M), Richard L. Hoover (A), Christian L. Jensen (A), Chansler G. Johnson (M), W. D. McMillan (M), Vernon N. Paulson (A), Ralph K. Reynolds (M), W. King Simpson (M), Louis Ferdinand Skodi (J), Evert Lloyd Venstrom (J), John Vocelka (M), Ross G. Wilcox (M).

Cincinnati Section

Harry R. Burdick (A), Frank Richard Flaherty (A), William Thomas Hammelrath (M), William H. Pruhs, (J).

Cleveland Section

Norman A. Bast (J), Albert M. Currier, Jr. (A), Robert W. Finley (M), Dwain E. Fritz (M), Herbert P. Gusdane (M), Worth Johnson (A), Joseph Kepic, Jr. (J), Robert L. Nancarrow (M), Zane C. Odenkirk (M), Herbert H. Schmiel (M), Jack Edward Schmitt (J), William L. Seitz (M).

Colorado Group

George Edgar Zeigler (J).

Dayton Section

E. P. Hartman (M).

Detroit Section

Chester M. Adams (M), John Arzoian (J), Raymond Earl Balbach (A), Albert S. Beam (M), Arch H. Copeland, Jr. (A), Harry F. Davis (A), William E. Day, Sr. (M), Billy Jay Ellerthorpe (J), Ned Fuller, Jr. (M), R. Arthur Gaiser (M), William R. Gillette (M), Kenneth Owen Glattes (M), Wilson T. Groyes (M), Peter Hugh Haller (A), David W. James (M), Clarence H. Jorgensen, Jr. (J), Harold V. Joyce (M), Mark A. Lightfoot (M), Chris William Madson (M), Gordon I. McBain (J), Louis Ivo Monti (J), Leonard A. Nejman (J), Francis J. Newton (M), Rob-

Continued on Page 118


7200 LB. THRUST...PLUS
LOW SPECIFIC FUEL CONSUMPTION
NO COBALT OR COLUMBIUM
2500 LBS. – 37.5 IN. DIAMETER
IN PRODUCTION IN 1951
WRIGHT
AERONAUTICAL CORPORATION • WOOD-RIDGE, N. J.
A DIVISION OF
CURTISS-WRIGHT
The World's Finest Aircraft Engines
WRIGHT OFFERS: employment opportunities to qualified personnel; subcontract work to qualified manufacturers.

New Members Qualified

Continued

ert H. Nihill (J), Paul Prior (J), Donald Wayne Reynolds (J), Arthur Rudolph (M), Arthur M. Sterren (M), Robert Harrison Stimpson (M), John N. Straky (M), Louis F. Stuckey (J), Alec B. Thomson (A), Robert O. Williams (J).

Indiana Section

Walter H. Hocker, Jr. (M), Edward S. Pascoe (M).

Metropolitan Section

Earl Wilson Ball (M), Ralph I. Bost (M), Edward C. Fisher (A), Roy F. Hodson (M), Joseph P. Koplick (A), James B. Lightburn (A), Fred M. Morris (M), Richard S. Palmer (M), Emanuel Steinberg (J), Louis Steinberg (M), Harold A. Strohman (M).

Mid-Michigan Section

Robert Bremer (A).

Milwaukee Section

Ralph E. Berndt (J), Llywelyn Charles Evans (M), James F. Johnson, Jr. (J), George G. McManis (A), Howard R. Turtle, Jr. (J).

Mohawk-Hudson Group

James C. Huntington (A).

Montreal Section

Guy L. Blain (M), Marcel Clark (A), Leslie W. Douglas (A), E. Gray-Donald (M), Edward Evan Higgins (A), Leonard James Macdonald (M), William Earle MacKenzie (A), Sydney Sylvester Payne (M), Arthur Thomas Roblin (A), Robert Short (A).

New England Section

Edgar Rose (J), Alfons Goedecke Taylor (SM).

Northern California Section

S. Cameron Hackney (A).

Northwest Section

Andrew C. McDermott (J), Ralph J. Shields (A).

Oregon Section

Jack P. Converse, Jr. (J), William H. Green (A), Phil E. Parks (A).

Philadelphia Section

Warren E. Barker (J), Thomas J. Bowes (A), Walter Leedom Dutton (J), Richard A. Spraker (M), Raymond J. Thomas (M).

Pittsburgh Section

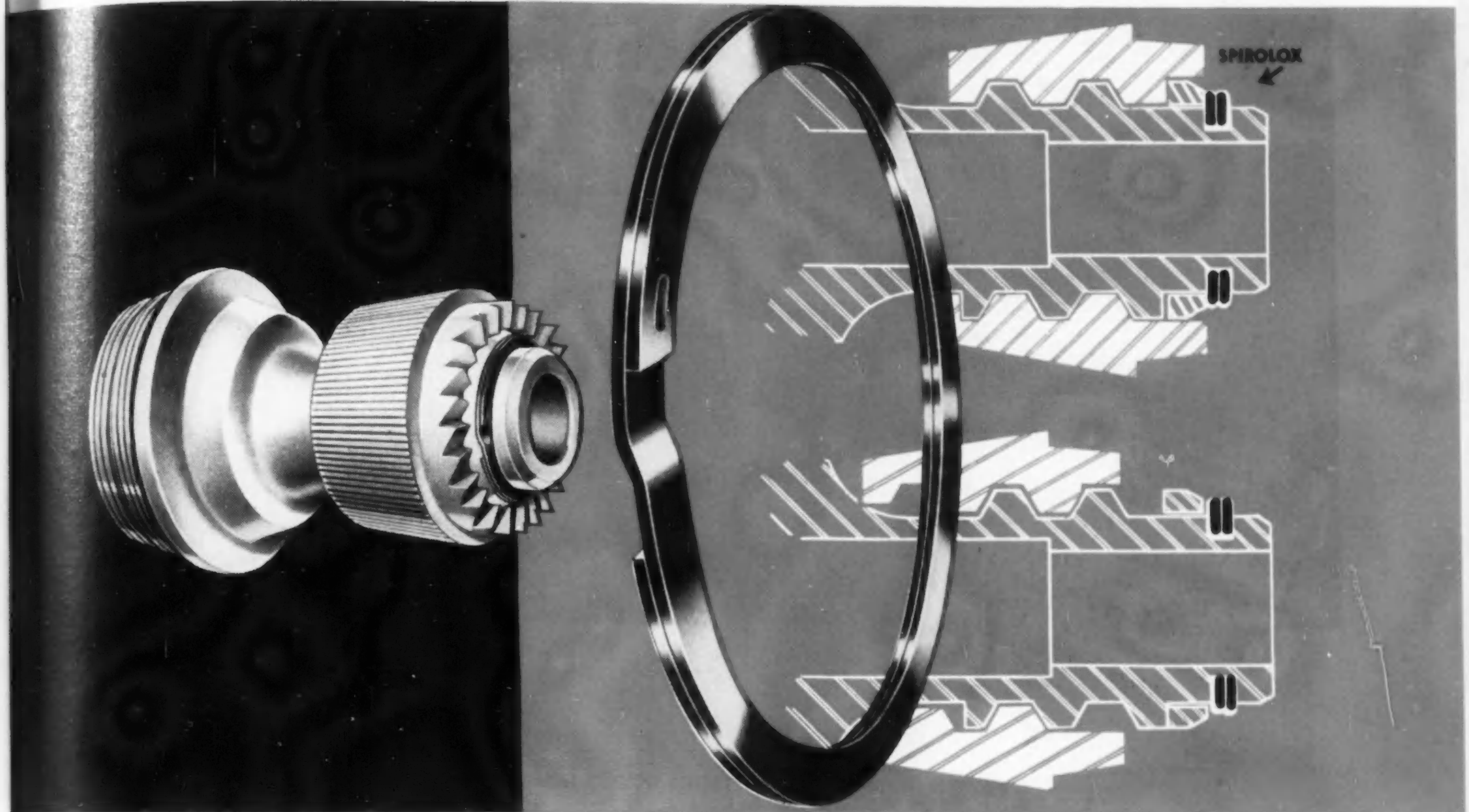
Richard J. Reich (J).

Salt Lake Group

E. Arthur Thompson (J).

Continued on Page 121

...e of hundreds of ways in which Industry uses **SPIROLOX** to solve Retaining Problems:



how SpirOlox withstands repetitive shock loads

without jumping the groove!

One reason why manufacturers everywhere think of Spirolox as "the better way to hold moving parts together," is its ability to resist shock loads and thrust forces up to its own shear strength. That means Spirolox *stays put!* The secret of this unique locking characteristic lies in the patented Spirolox *two-turn* construction. Through this design, the opening or closing force is resisted by friction created between the two turns. Under thrust, they are actually "squeezed" together, thus forming a "friction lock", which makes the ring stay in the groove.

Illustrated above is a typical example of how one company put to work this unique "stay-put" characteristic of Spirolox in a Coaster Brake Assembly. Blueprint points out how collar rides to Spirolox, making it necessary for the retainer ring to withstand repeated shock loads due to application of brake, without shearing or jumping the groove. Unusual conformability of Spirolox is also graphically illustrated by this application. Note how clearance is provided for the collar when it rotates over the retaining ring. Spirolox always provides a uniform shoulder. There are no gaps or breaks to interrupt its uniform circumference; no lugs or projections to create "weak spots."

Send now for FREE SPIROLOX SPECIFICATIONS CATALOG—it may help you obtain simpler, more compact design; elimination of trouble spots; removal of awkward parts or costly machining used with former fastening methods. Start Spirolox betterments your way TODAY. Find out how to do your retaining jobs surer, quicker, more economically, by sending for your copy of the Spirolox Catalog. Write Ramsey Corporation, St. Louis 8, Missouri.

Spirolox Retaining Rings are covered by United States Patent No. 2,450,425 and Foreign Patents. Other patents pending.

R5566

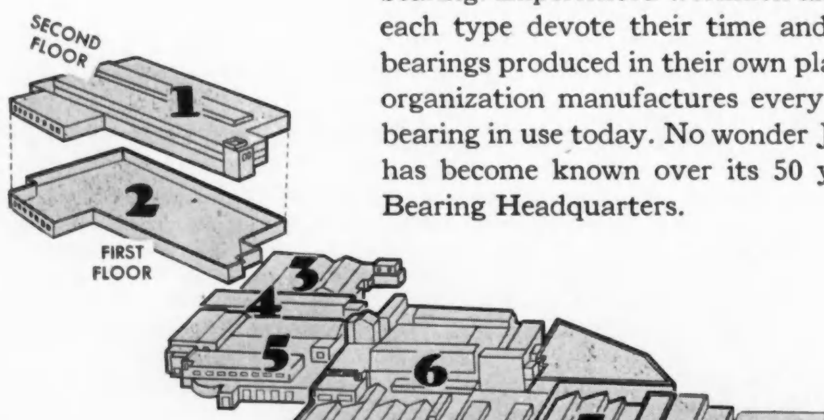
the better way

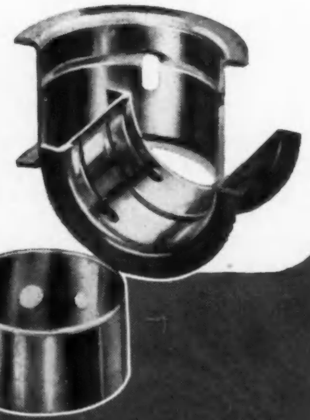
SpirOlox RETAINING RINGS to hold moving parts TOGETHER!

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

gapless • concentric • requires no special tools • easy-in, easy-out • re-usable • stays put

JOHNSON SLEEVE BEARINGS actually come from seven adjacent plants—seven—each devoted to producing a particular type bearing. Experienced workmen and specialists in each type devote their time and efforts to the bearings produced in their own plants. This large organization manufactures every type of sleeve bearing in use today. No wonder Johnson Bronze has become known over its 50 years as Sleeve Bearing Headquarters.





SLEEVE BEARING HEADQUARTERS *Since* 1901

Johnson Bronze

675 SOUTH MILL STREET • NEW CASTLE, PA.

New Members Qualified

Continued

San Diego Section

Ben R. Bentson (J).

Southern California Section

Harold W. Ensign (M), Darrell Boyd Harmon, Jr. (M), B. C. Monesmith (M), Cameron W. Prentice (M), A. John Trainor (A).

Southern New England Section

T. Joseph Keane (A).

Texas Section

C. E. Hale (A), John Robert Nelson (J), Glenn L. Scherer (A).

Virginia Section

Ralph Allen Amos (J).

Washington Section

Edward B. Heyl (SM).

Western Michigan Section

Jack M. Hamilton (J), Ian K. MacGregor (M), Benjamin F. Park (A).

Outside of Section Territory

Lee V. Brown (SM), Howell H. Heck (J), David H. C. Hoh (J), Rene G. Lamadrid (J), Avard A. Marr (A), Benjamin McLain (M), Frederick W. Scheel (M), Cyril Standen (M), Edwin B. Stueland (J), Roger Raymond Yoerger (J).

Foreign

John Anthony Fertnig (A), India; Sergio Goldenberg (J), Chile; Stephen Silvester Lancefield (FM), England; Horst Muller-Carioba (J), Brazil; Kanahala Bandaralage Lawrence Perera (FM), Ceylon; K. Ramachandran (FM), England; Simpson Sebba (FM), South Africa.

Applications Received

The applications for membership received between June 10, 1951, and July 10, 1951 are listed below.

Atlanta Group

Philip G. North, Jr.

British Columbia Section

Peter Johnson.

Buffalo Section

Anthony Peranio.

Canadian Section

Albert Bear, E. Donald Beaumont, Wallace Gordon Chalmers, T. J. Em-

Continued on Page 122

Applications Received

Continued

mert, Walter Clifton Fleming, Charle Dean Roice, William James Tomlinson

Central Illinois Section

Gordon J. Mason, William Lindland Mattheessen.

Chicago Section

Fred J. Barbain, Frank Joseph Charhut, Arthur F. Dewsberry, Charles J. Domke, William Benjamin Gross, Robert A. Harmon, Charles J. Jacobus, Robert Edward Johnson, John Edward King, Lester G. Kopp, Paul S. Krause, Frank William Mellberg, Samuel P. Mitchell, Barrett B. Russell, III, Herman A. Schubert, Murray Senkus, Charles L. Small, Paul K. Zimmerman.

Cincinnati Section

Thomas H. Shea.

Cleveland Section

Clayton H. Bradshaw, Thomas J. Durkin, Robert C. Ferber, Frank Hribar, Jr., Robert S. Lee, Richard Allen Morris, P. J. Reeves, Richard D. Sampson, Charles Leo Teeter, Joe Stanich.

Detroit Section

Frank Henry Abar, Jr., Harold T. Adkins, Thomas L. Belanger, Alexander H. Ben-Azul, Harold Nelson Bogart, Jess L. Bordner, Jack L. Campau, Jack Edward Charipar, Ralph A. Clark, Orville E. Cullen, Edward M. Delahanty, George G. Descamps, Harry S. Ford, Jr., Ira Garfunkel, Fred D. Green, Edwin E. Hebb, Jr., David W. Lee, Lucille Joyce Pieti, Raymond A. Pittman, Harold B. Price, Thomas R. Reid, James B. Retzloff, K. W. Skrade, Jerry Donald Stoll, James B. Thompson, Richard A. Vining, John Louis Thoms.

Hawaii Section

Howard N. Mosher, David M. Vieira.

Indiana Section

Duard B. Colyer, Jr., Robert Gordon Greenawalt, B. Byron LeMay, Jr., Robbert H. Yeakey.

Metropolitan Section

Ernest G. Balogh, Thomas R. Bennett, John Crabtree, Peter L. Brown, Malcolm Joseph Dodd, John William Gregorits, Melvin M. Hyams, Alexander Lengyel, William H. Nienhauser, Kurt Rosenbaum.

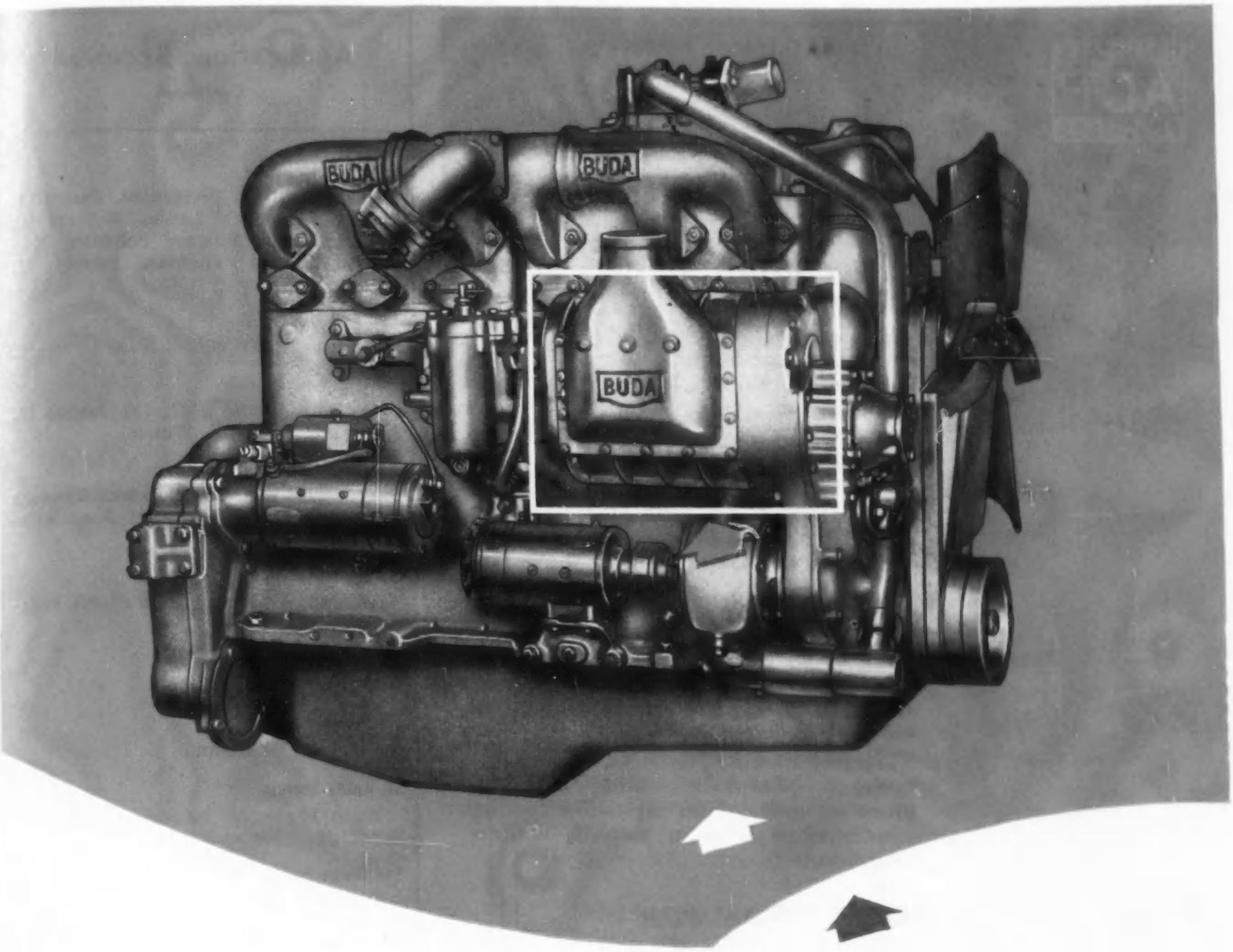
Mid-Continent Section

Joseph H. Spaan, III.

Mid-Michigan Section

Adolph F. Braun, Roy S. Dahmer, Henry F. Wiebrecht.

Continued on Page 124



POWER BUILT-IN

BUDA Diesels use B-W Superchargers built in for added horsepower and economy

The Buda Company of Harvey, Illinois, uses B-W Superchargers on their diesels. This automotive diesel engine, Model 6-DAS-844, develops 280 brake horsepower at 2,100 r.p.m. Designed for heavy-duty truck operation both at sea level and altitude. The supercharger on this engine is one of a standard line developed by Pesco Products Division.

For motor truck, marine, railway or general industrial applications, supercharging means savings in engine space and weight . . . means power to pull heavy loads . . . means sea level operation at high altitudes. All these extra benefits without corresponding increases in operating costs.

The engine manufacturer who wants to pack more power into a given engine size . . . or who wants to add an entire new series of models to his line without retooling or the expense of redesign, can do so simply by equipping his present line with B-W Superchargers. One of our engineers will gladly explain how this can be done. There is no obligation. Write today to:

engineering Pesco production
PRODUCTS DIVISION

BORG-WARNER CORPORATION
24700 NORTH MILES ROAD BEDFORD, OHIO

Applications Received

Continued

Milwaukee Section

James Donald Bonneville, James G. Darby, Lester O. Laabs, William T. Odum, Robert Edward Schaefer, Edward Emmett Thomas, Harold H. Winston.

Mohawk-Hudson Group

C. Stewart Ferguson, Hans Schwarz.

New England Section

Edward Joseph Hill, Jr., Joseph B. Kaplan, Clifford F. Walsh.

Northern California Section

Frederick P. Conant, Robert Thomas Holmes, Victor C. Peterson, John Robert White.

Northwest Section

William A. Greene, Paul Pigott, Robert Olaf Ringoen.

Oregon Section

Stanley F. Kinne.

Pittsburgh Section

Elroy N. Beisheim.

St. Louis Section

John Frederick Hendel, Charles M. Hirst, Jr.

San Diego Section

Robert Lynn Engleman.

Southern California Section

Joseph C. Haile, Robert Bruce Miller, Randall Weston Richards, Jr., Garmon D. Simmons, Francis Livingston Smith, Jr., Glenn H. Taylor, Darrell M. Vincent, Arlie A. Wallace.

Spokane-Intermountain Section

Ben L. Cadwell.

Syracuse Section

William Arthur Brown, Walter H. Canfield, Jr., George A. Knapp.

Twin City Section

Herbert W. Templeton.

Washington Section

James Ewell Erwin, Jr., Thomas J. Pearsall.

Wichita Section

H. W. Winkler.

Williamsport Group

Marshall E. Becker.

Outside of Section Territory

Harold W. Austrow, Eric E. Johnson, Lloyd Douglas Smith, W. E. Trumpp, Jerry G. Watters.

Foreign

Peter Bonde Andersen, Scotland; Joseph Cheetham, New Zealand; Lt. Jose Anselmo daSilva, Brazil; William Albert Finch, England; Bhau Yeshwant Kadam, India; Sven-Olaf Karlsson, Sweden.

For the Sake of Argument

Solutions and Problems;
Answers and Questions. . . .

By Norman G. Shidle

"Go to the boss with suggested solutions; not with problems. Try to take him more answers than questions."

Thus we heard a father advising his about-to-enter-business son the other day.

But several of dad's own business associates happened to be there too. One of them didn't exactly agree . . . and said so.

"You try that with some bosses, Dave, and you'll find yourself looking for another job pretty quick," the dissenter advised. "I'll never forget one Joe Blow I worked for years ago. He had to have credit for everything. The one sure way to get a turndown was to suggest your own ideas to him. He frowned automatically on anything that anybody else thought of.

"Of course, he didn't get many ideas offered to him—and his department had to falter ahead with the limited number and quality of ideas he generated himself. . . . That wasn't so good. But, just the same, going to him with solutions instead of problems was no way to get ahead."

Dad listened to the objector as attentively as did junior. But he was quick to counter with:

"OK, but you saw only the problems in dealing with your Joe Blow. You didn't see the easy chances to get him on your side. Joe Blow or no Joe Blow, an executive likes the fellow from whom he gets more answers than questions. But ideas have to be packaged differently for different temperaments. All you have to do with the Joe Blows is to present your solutions as ideas suggested by something Joe said yesterday . . . or last week or last year.

"Sure, Joe won't give you credit in talking to others. He'll try to make them think he did it all himself. . . . But you'll come out all right in the long run. Don't forget, all of Joe Blow's superiors weren't behind the door when the brains were passed out.

"Besides, son, for one Joe Blow you will work for, there will be at least half a dozen executives with their eyes on getting a good job done—not on themselves. . . . So I still think the advice is good."

A few moments of silence. Then from junior: "Gee, Pop, I guess there *is* some sense to that idea."